PATENT ABSTRACTS OF JAPAN

(11)Publication number : 11-094863
(43)Date of publication of application : 09.04.1999

(51)Int.Cl. G01N 37/00

(21)Application number : 09-267725
(22)Date of filing : 12.09.1997

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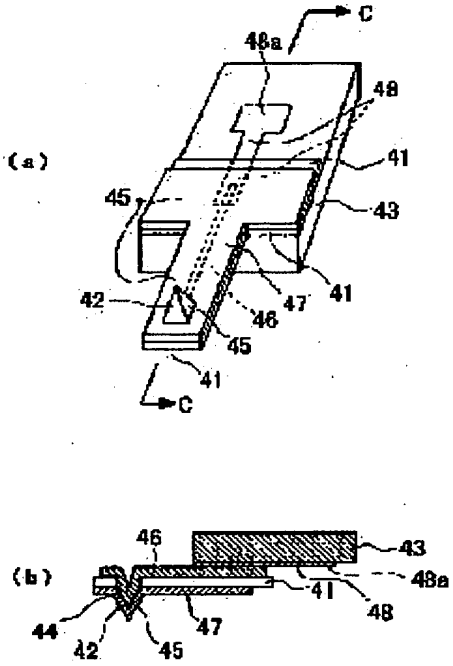
(54) CANTILEVER AND ITS MANUFACTURE

(57)Abstract:
PROBLEM TO BE SOLVED: To enhance measuring precision and resolution of temperature distribution and heat conductivity distribution, protrude a probe and a support for a flexible plate in the contrary direction, heighten a resonant frequency and enable fast scanning.
SOLUTION: A cantilever is provided with a flexible plate 41, a probe 42 protruded on the lower face of the edge side area of the flexible plate 41, and a support 43 composed of insulation material joined on the upper face of the base end side area of the flexible plate 41. A thermocouple composed of metal films 44, 45 is provided on the probe 42. The metal film 44 continues from the part of the thermocouple, and is formed on the face of the side of the support 43 of the flexible plate 41. The metal plate 45 continues from the part of the thermocouple, and is formed on the face of the side of the probe 41 of the flexible plate 41.



LEGAL STATUS

[Date of request for examination]

[Date of sending the examiner's decision of rejection]

[Kind of final disposal of application other than the examiner's decision of rejection or application converted registration]

[Date of final disposal for application]

[Patent number]

[Date of registration]

[Number of appeal against examiner's decision of rejection]

[Date of requesting appeal against examiner's decision of rejection]

[Date of extinction of right]

CLAIMS

[Claim(s)]
[Claim 1] The flexible plate which consists of an insulating material, and the probe which protruded on the field of one side of the tip side field of this flexible plate, The base material joined by the field of the other side of the end face side field of said flexible plate, The thermocouple which becomes a preparation and said probe from junction to the 1st metallic material and the 2nd metallic material is formed. Said 1st metallic material is continuously formed in the field by the side of said base material of said flexible plate from the part of said thermocouple. In the field by the side of said base material of said flexible plate The cantilever characterized by forming the 1st electric conduction film for wiring which extends to said end face side field while connecting with said 1st metallic material electrically.
[Claim 2] So that said base material may consist of an electrical conducting material and said the 1st electric conduction film for wiring and said base material may be connected electrically Said flexible plate and said base material are joined, and said 2nd metallic material is continuously formed in the field by the side of said probe of said flexible plate from the part of said thermocouple. The cantilever according to claim 1 characterized by forming in the field by the side of said probe of said flexible plate the 2nd electric conduction film for wiring which extends to said end face side field while connecting with said 2nd metallic material electrically.
[Claim 3] Said base material consists of an insulating material. Between said flexible plates and said base materials It intervenes so that a part of 1st conductor for external connection may be electrically connected with said 1st electric conduction film for wiring. Said a part of other 1st conductor for external connection is drawn outside, and said 2nd metallic material is continuously formed in the field by the side of said probe of said flexible plate from the part of said thermocouple. The cantilever according to claim 1 characterized by forming in the field by the side of said probe of said flexible plate the 2nd electric conduction film for wiring which extends to said end face side field while connecting with said 2nd metallic material electrically.
[Claim 4] Said 1st conductor for external connection is a cantilever according to claim 3 characterized by being the electric conduction film for wiring formed in the field which does not lap with said flexible plate from the field which laps with said flexible plate in the field by the side of said flexible plate of said base material, having covered.
[Claim 5] Said base material consists of an insulating material. Between said flexible plates and said base materials It intervenes so that a part of 1st conductor for external connection may be electrically connected with said 1st electric conduction film for wiring. Said a part of other 1st conductor for external connection is drawn outside, and said 2nd metallic material is continuously formed in the field by the side of said base material of said flexible plate from the part of said thermocouple. In the field by the side of said base material of said flexible plate The 2nd electric conduction film for wiring which extends to said end face side field while connecting with said 2nd metallic material electrically is formed. Between said flexible plates and said base materials The cantilever according to claim 1 characterized by what it intervened so that a part of 2nd conductor for external connection might be electrically connected with said 2nd electric conduction film for wiring, and said a part of other 2nd conductor for external connection was drawn for outside.
[Claim 6] Each of said 1st and 2nd conductors for external connection is a cantilever according to claim 5 characterized by being the electric conduction film for wiring formed in the field which does not lap with said flexible plate from the field which laps with said flexible plate in the field by the side of said flexible plate of said base material, having covered.
[Claim 7] Claims 1 and 3 characterized by for said base material having consisted of a glass member containing movable ion, and said flexible plate and said base material being joined by anode plate junction thru/or a cantilever given in either of 6.
[Claim 8] It is the approach of manufacturing a cantilever according to claim 4, and is the structure which has a substrate, the thin film formed in this substrate front face, and the 1st metal membrane. While patterning of said thin film is carried out according to the configuration of said flexible plate, it has opening in the location corresponding to said probe. It has a crevice for said substrate to imprint the configuration of said probe under said opening of said thin film. The process by which extended on said thin film from this field, and patterning was carried out according to the configuration of said 1st electric conduction film for wiring while said 1st metal membrane was formed in the wrap field in said crevice and which prepares the structure, The process which prepares the insulating member by which the 2nd metal membrane by which patterning was carried out according to the configuration of said 1st conductor for external wiring was formed in the inferior surface of tongue, Alignment of said structure and said insulating member is carried out so that said a part of 1st metal membrane and said a part of 2nd metal membrane may lap and contact. The manufacture approach of the cantilever characterized by having the process which forms the 3rd metal membrane in the near predetermined field to which said substrate in the process which joins the inferior surface of tongue of said insulating member to the top face of said thin film, the process which removes said substrate, and the structure which remained after removal of said substrate existed.
[Claim 9] The process at which said process which prepares said structure forms a thin film in said substrate front face, The process which etches into this thin film the parts of the process which forms said opening, and said substrate exposed from the opening concerned, and forms the trench as said crevice in the bottom of the opening concerned in said substrate, The manufacture approach of the cantilever according to claim 8 characterized by having the process which forms said 1st metal membrane by which patterning was carried out according to the configuration of said 1st electric conduction film for wiring so that it might extend on said thin film from the field concerned, while said crevice was located in the wrap aforementioned field.
[Claim 10] It is the approach of manufacturing a cantilever according to claim 6, and is the structure which has a substrate, the thin film formed in this substrate front face, and the 1st and 2nd metal membranes. While patterning of said thin film is carried out according to the configuration of said flexible plate, it has opening in the location corresponding to said probe. It has a crevice for said substrate to imprint the configuration of said probe under said opening of said thin film. While said 1st metal membrane is formed in a wrap field in

said crevice, extend on said thin film from this field, and patterning is carried out according to the configuration of said 1st electric conduction film for wiring. The process by which extended on said thin film from the lap field concerned, and patterning was carried out according to the configuration of said 2nd electric conduction film for wiring while being formed so that said 2nd metal membrane might lap with said 1st metal membrane in said crevice and which prepares the structure, The process which prepares the insulating member by which the 3rd and 4th metal membranes by which patterning was carried out respectively according to the configuration of said 1st and 2nd conductors for external wiring were formed in the inferior surface of tongue, Alignment of said structure and said insulating member is carried out so that said a part of 2nd metal membrane and said a part of 4th metal membrane may lap and contact, while said a part of 1st metal membrane and said a part of 3rd metal membrane lap and contact. The manufacture approach of the cantilever characterized by having the process which joins the inferior surface of tongue of said insulating member to the top face of said thin film, and the process which removes said substrate.

[Claim 11] The process at which said process which prepares said structure forms a thin film in said substrate front face, The process which etches into this thin film the parts of the process which forms said opening, and said substrate exposed from the opening concerned, and forms the trench as said crevice in the bottom of the opening concerned in said substrate, The process which forms said 1st metal membrane by which patterning was carried out according to the configuration of said 1st electric conduction film for wiring so that it might extend on said thin film from the field concerned while said crevice is located in the wrap aforementioned field, The process which forms said 1st metal membrane by which patterning was carried out according to the configuration of said 1st electric conduction film for wiring so that it might extend on said thin film from the field concerned while said crevice is located in the wrap aforementioned field, The process which forms said 2nd metal membrane by which patterning was carried out according to the configuration of said 2nd electric conduction film for wiring so that it might extend on said thin film from the lap field concerned while being located so that it may lap with said 1st metal membrane in said crevice, The manufacture approach of the cantilever according to claim 10 characterized by ****(ing).

[Claim 12] Said process which prepares said structure is the manufacture approach of the cantilever according to claim 9 or 11 characterized by having the process which makes the wall of said trench of said substrate make it steep by thermal oxidation before said process which is after said process which forms said trench, and forms said 1st metal membrane.

[Claim 13] It is the manufacture approach of the cantilever according to claim 8 to 12 which said insulating member consists of a glass member containing movable ion, and is characterized by said process to join being a process which carries out anode plate junction of the inferior surface of tongue of said insulating member on the top face of said thin film.

[Translation done.]

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] This invention relates to the suitable cantilever for a scan mold heat measurement microscope, and its manufacture approach especially about the cantilever used for a scan mold probe microscope, and its manufacture approach.
[0002]
[Description of the Prior Art] In recent years, the scan mold probe microscope using the physicochemical interaction between a probe and a sample is studied actively. Especially the scan mold heat measurement microscope (STI: Scanning Thermal Iemager) that measures temperature distribution and thermal conductivity distribution on the front face of a sample is a microscope by which promising ** is carried out as the analysis technique of a semi-conductor of operation, or an analysis technique of the thermal property of an ingredient. It is imaging ******** to coincidence about the concavo-convex image of bending change of this cantilever by the interaction force produced between the probes and the sample front faces which protruded on the tip side field of this cantilever to a sample, and the temperature distribution of thermoelectromotive force to a sample or the heat-conductivity distribution which generated with the temperature measured with the thermocouple which is formed in the probe of this cantilever and consists of dissimilar metal junction using the cantilever which has the minute spring force formed with a thin film material under this microscope.
[0003] An example of the conventional cantilever used under this scan mold heat measurement microscope is shown in drawing 7 . The outline perspective view in which drawing 7 (a) shows this conventional cantilever, and drawing 7 (b) are the outline sectional views which met the A-A line in drawing 7 (a).
[0004] This conventional cantilever is equipped with the flexible plate 1 which consists of a silicon nitride film as an insulating material, the probe 2 which protruded on the inferior surface of tongue of the tip side field of this flexible plate 1, and the base material 3 joined to the inferior surface of tongue of the end face side field of the flexible plate 1. Therefore, the probe 2 and the base material 3 are projected in the same direction to the flexible plate 1. The probe 2 consists of metal membranes 13 and 14 of a mutually different class, and junction of the metal membranes 13 and 14 in the probe 2 concerned constitutes the thermocouple. The metal membrane 13 is caudad projected from opening formed in the part corresponding to a probe 2 in the flexible plate 1. The base material 3 consists of a silicon layer 10 and a silicon nitride film 12 formed in the inferior surface of tongue of this silicon layer 10. The electric conduction film 4 for wiring which consists of a metal membrane 13 which continued from the part of the thermocouple of a probe 2 is missing from said end face side field, and is formed in the top face of the flexible plate 1. Moreover, on the end face side field of the flexible plate 1, the electrode pattern 5 for electrical installation with the exterior which consists of a metal membrane 13 which followed the electric conduction film 4 for wiring (pad section) is formed. The metal membrane 14 is formed in the whole inferior surface of tongue of the metal membrane 13 projected from said opening of the flexible plate 1 and this flexible plate 1, and a base material 3.
[0005] The cantilever shown in drawing 7 is manufactured by the following approaches. Drawing 8 is the outline sectional view showing an example of the production process of the cantilever shown in drawing 7 .
[0006] First, the silicon substrate 10 of field (100) bearing is prepared, and the silicon nitride films 11 and 12 which serve as an ingredient of the flexible plate 1 to both sides of this substrate 10 are formed. Next, opening 11a of the shape of a square to which the front face of a substrate 10 is exposed is formed in the predetermined part of a silicon nitride film 11 by carrying out patterning of the silicon nitride film 11 on top using the lithography method and the dry etching method. Then, anisotropic etching of the part of the substrate 10 exposed from opening 11a is carried out by wet etching, and square drill-like trench 10a is formed in the bottom of opening 11a at a substrate 10 (drawing 8 (a)). Next, patterning of the metal membrane 13 is carried out to the field which is equivalent to wrap subregion, the field equivalent to said electric conduction film 4 for wiring, and said electrode pattern 5 in this trench 10a on the substrate of the condition which shows in drawing 8 (a) by the lift-off method (drawing 8 (b)).
[0007] Next, while carrying out patterning of the silicon nitride film 11 on top according to the configuration of the flexible plate 1 using the lithography method and the dry etching method, according to the configuration of a base material 3, patterning of the silicon nitride film 12 at the bottom is carried out (drawing 8 (c)). It is eluted and the silicon section of a substrate 10 which was immersed in the KOH water solution and finally exposed the substrate of the condition which shows in drawing 8 (c) is removed (drawing 8 (d)). The metal membrane 14 of an ingredient which is finally different from said metal membrane 13 on the whole inferior surface of tongue of the structure of the condition which shows in drawing 8 (d) is formed (drawing 8 (e)). Thereby, the cantilever shown in drawing 7 is completed. In addition, according to this manufacture approach, a silicon nitride film 11 constitutes the flexible plate 1, and the remaining substrate 10 and the remaining silicon nitride film 12 constitute a base material 3.
[0008] Moreover, other examples of the conventional cantilever used under the scan mold heat measurement microscope are shown in drawing 9 . The outline sectional view in which drawing 9 (a) shows this conventional cantilever, and drawing 9 (b) are the B-B view outline top views in drawing 9 (a).
[0009] This conventional cantilever is constituted using the cantilever for atomic force microscopes marketed. That is, the cantilever for atomic force microscopes concerned consists of the flexible plate 101 and probe 102 (the probe 102 protrudes on the inferior surface of tongue of the tip side field of the flexible plate 101.) which were constituted from a silicon nitride film by one, and a base material 103 which consists of a glass member joined to the top face of the end face side field of the flexible plate 1. And the metal membrane 104,105 of a class which is different as shown in drawing 9 (b) is partially formed in the field by the side of the probe 102 of

the cantilever for atomic force microscopes concerned, the conventional cantilever shown in drawing 9 becomes [whether the part of a probe 102 is included, and], in the field of a large rhombus, a metal membrane 104,105 laps mutually, and is joined, and the lap part concerned constitutes the thermocouple. Therefore, the probe 106 of the cantilever shown in drawing 9 consists of a probe 102 which consists only of silicon nitride of said cantilever for atomic force microscopes, and a metal membrane 104,105 which lapped mutually [the part formed in the probe 102 inferior surface of tongue concerned].

[0010]

[Problem(s) to be Solved by the Invention] According to the conventional cantilever shown in the conventional cantilever and conventional drawing 9 which are shown in said drawing 7 , as mentioned above, since the thermocouple was formed in the probe, it was possible but to have acquired the concavo-convex image of a sample, the temperature distribution of a sample, or thermal conductivity distribution to coincidence, and as stated below, each conventional cantilever mentioned above had merits and demerits.

[0011] It will be decided by the cantilever shown in drawing 7 in the magnitude and the location of opening 11a of a silicon nitride film 11 which were formed on the substrate 10 which the magnitude and the location of a thermocouple mentioned above so that the explanation mentioned above may show. The opening 11a concerned can be formed using the lithography method (an aligner is used) and the dry etching method, as mentioned above. For this reason, while being able to form the magnitude and the location of said opening 11a with a very sufficient precision, it is possible to make area of opening 11a small. Therefore, area of a thermocouple can be made small while being able to form the magnitude and the location of a thermocouple with a very sufficient precision. Consequently, in the cantilever shown in drawing 7 , the precision and resolution of measurement of the temperature distribution on the front face of a sample or thermal conductivity distribution were high.

[0012] However, in the cantilever shown in drawing 7 , since the probe 2 and the base material 3 had projected in the same direction to the flexible plate 1, following un-arranging had arisen. Drawing 10 (a) is the outline sectional view showing typically signs that the front face of a sample 30 is measured by the cantilever shown in drawing 7 . Although it is necessary to make the probe 2 prepared in the tip side field of the flexible plate 1 at the time of measurement contact or approach the front face of a sample 30 as shown in drawing 10 (a) Since the probe 2 and the base material 3 have projected in the same direction to the flexible plate 1 by the cantilever shown in drawing 7 at this time In order for the corner ahead of a base material 3 to tend to hit a sample 30 and to avoid this, it had the fault that the part (namely, lever section) to which the base material 3 in the flexible plate 1 is not joined had to be lengthened comparatively. As everyone knows, under the scan mold probe microscope, in order to realize rapid scanning, it was desired for the resonance frequency of a cantilever to be high, but since the lever section had to be lengthened as mentioned above, the problem that a scan speed had to be made late about [conventional] with 1/50 had arisen.

[0013] On the other hand, in the cantilever shown in drawing 9 , since the probe 106 and the base material 103 have projected to the opposite direction to the flexible plate 101 As [hit / the corner of a base material 103 / as shown in drawing 10 (b) / at the time of measurement / a sample 30] The part (namely, lever section) to which the base material 24 in the flexible plate 101 is not joined can be shortened, resonance frequency of the cantilever concerned can be made high, and rapid scanning can be realized. Drawing 10 (b) is the outline sectional view showing typically signs that the front face of a sample 30 is measured by the cantilever shown in drawing 9 .

[0014] However, in the cantilever shown in drawing 9 , although a metal membrane 104,105 is formed in the field by the side of the probe of the cantilever for atomic force microscopes, mask vacuum evaporationo etc. cannot but perform formation of a metal membrane 104,105. For this reason, while being unable to form the magnitude and the location of a lap part (namely, thermocouple) of a metal membrane 104,105 with so sufficient a precision, the area of the thermocouple concerned cannot but become large. For this reason, in the cantilever shown in drawing 9 , the precision and resolution of measurement of the temperature distribution on the front face of a sample or thermal conductivity distribution were falling.

[0015] This invention was made in view of such a situation, can raise the magnitude of a thermocouple, and the precision of a location, and the precision and resolution of measurement of the temperature distribution on the front face of a sample or thermal conductivity distribution can be raised, And when a probe and a base material project in an opposite direction to a flexible plate, it aims at providing with the manufacture approach the cantilever which can fulfill to coincidence the conditions of being able to raise resonance frequency and making rapid scanning possible, and a list.

[0016]

[Means for Solving the Problem] In order to solve said technical problem, the cantilever by the 1st mode of this invention The flexible plate which consists of an insulating material, and the probe which protruded on the field of one side of the tip side field of this flexible plate, The base material joined by the field of the other side of the end face side field of said flexible plate, The thermocouple which becomes a preparation and said probe from junction to the 1st metallic material and the 2nd metallic material is formed. Said 1st metallic material is continuously formed in the field by the side of said base material of said flexible plate from the part of said thermocouple. In the field by the side of said base material of said flexible plate While connecting with said 1st metallic material electrically, the 1st electric conduction film for wiring which extends to said end face side field is formed.

[0017] Said 1st metallic material may be prolonged as it is, what may consist of different ingredients and added two or more film one by one is sufficient as said 1st metallic material, and the film which consists of two or more layers is sufficient as said 1st electric conduction film for wiring.

[0018] Since the 1st metallic material which constitutes a thermocouple is continuously formed in the field by the side of said base material of said flexible plate (namely, field of a probe and the opposite side) from the part of a thermocouple according to this 1st mode, before removing the substrate which is in the middle of manufacture, is used at the time of manufacture, and is removed at the end at it, the 1st metallic material can be formed. Therefore, on the occasion of film formation of the 1st metallic material, the accurate film formation technique using aligners, such as the lift-off method, is employable. For this reason, according to said 1st mode, while being able to form the magnitude and the location of a thermocouple with a very sufficient precision, area of a thermocouple can be made small, as a result the precision and resolution of measurement of the temperature distribution on the front face of a sample or thermal conductivity distribution can be raised.

[0019] Moreover, in the cantilever by said 1st mode, a probe protrudes on the field of one side of a flexible plate, the base material is joined by the field of the other side of a flexible plate, and the probe and the base material have projected to the opposite direction to the flexible plate. Therefore, the part (namely, lever section) to which the base material in a flexible play is not joined can be shortened so that the corner of a base material cannot hit a sample at the time of measurement, resonance frequency of the cantilever concerned can be made high, and rapid scanning can be realized.

[0020] In the cantilever according [the cantilever by the 2nd mode of this invention] to said 1st mode So that said base material may consist of an electrical conducting material and said the 1st electric conduction film for wiring and said base material may be connected electrically Said flexible plate and said base material are joined, and said 2nd metallic material is continuously formed in the field by the side of said probe of said flexible plate from the part of said thermocouple. While connecting with said 2nd metallic material electrically, the 2nd electric conduction film for wiring which extends to said end face side field is formed in the field by the side of said probe of said flexible plate.
[0021] Said 2nd metallic material may be prolonged as it is, what may consist of different ingredients and added two or more film one by one is sufficient as said 2nd metallic material, and the film which consists of two or more layers is sufficient as said 2nd electric conduction film for wiring.
[0022] This 2nd mode is the example of said 1st mode, and is an example using what forms the 2nd metallic material in the 1st metallic material and opposite side to a flexible plate, and consists of an electrical conducting material as a base material further. A 1st [of a thermocouple] metallic material side can be connected outside through the 1st electric conduction film for wiring and base material itself, and a 2nd [of a thermocouple] metallic material side can be connected outside through the 2nd electric conduction film for wiring. in addition, the 2nd metallic material from being formed in the probe side of a flexible plate By joining the 1st metallic material and 2nd metallic material through opening formed in the flexible plate, although membranes are formed by mask vacuum evaporationo etc. and the magnitude and the location of itself cannot be formed with so sufficient a precision Like the conventional cantilever shown in drawing 7 mentioned above, while being able to form the magnitude and the location of a thermocouple of a thermocouple with a very sufficient precision, area of a thermocouple can be made small.
[0023] Said base material consists of an insulating material in the cantilever according [the cantilever by the 3rd mode of this invention] to said 1st mode. Between said flexible plates and said base materials It intervenes so that a part of 1st conductor for external connection may be electrically connected with said 1st electric conduction film for wiring. Said a part of other 1st conductor for external connection is drawn outside, and said 2nd metallic material is continuously formed in the field by the side of said probe of said flexible plate from the part of said thermocouple. The 2nd electric conduction film for wiring which extends to said end face side field is formed in the field by the side of said probe of said flexible plate.
[0024] Said 2nd metallic material may be prolonged as it is, what may consist of different ingredients and added two or more film one by one is sufficient as said 2nd metallic material, and the film which consists of two or more layers is sufficient as said 2nd electric conduction film for wiring.
[0025] This 3rd mode is the example of said 1st mode, and is an example using what forms the 2nd metallic material in the 1st metallic material and opposite side to a flexible plate, and consists of an insulating material as a base material further. A 1st [of a thermocouple] metallic material side can be connected outside through the 1st electric conduction film for wiring, and the 1st conductor for external connection, and a 2nd [of a thermocouple] metallic material side can be connected outside through the 2nd electric conduction film for wiring. in addition, the 2nd metallic material from being formed in the probe side of a flexible plate By joining the 1st metallic material and 2nd metallic material through opening formed in the flexible plate, although membranes are formed by mask vacuum evaporationo etc. and the magnitude and the location of itself cannot be formed with so sufficient a precision Like the conventional cantilever shown in drawing 7 mentioned above, while being able to form the magnitude and the location of a thermocouple of a thermocouple with a very sufficient precision, area of a thermocouple can be made small.
[0026] the 4th voice of this invention -- the cantilever depended like -- said 3rd voice -- in the cantilever depended like, said 1st conductor for external connection is the electric conduction film for wiring formed in the field which does not lap with said flexible plate from the field which laps with said flexible plate in the field by the side of said flexible plate of said base material, having covered.
[0027] Although the 1st conductor for external connection may be conductors, such as a metallic foil and a metal wire, in said 3rd mode like said 4th mode If the electric conduction film for wiring formed in the field of a base material is used as 1st conductor for external connection For example, the cantilever concerned can be mass-produced using the batch process using a semi-conductor manufacturing technology like the manufacture approach by the 8th mode mentioned later, and the cantilever concerned can be offered cheaply.
[0028] Said base material consists of an insulating material in the cantilever according [the cantilever by the 5th mode of this invention] to said 1st mode. Between said flexible plates and said base materials It intervenes so that a part of 1st conductor for external connection may be electrically connected with said 1st electric conduction film for wiring. Said a part of other 1st conductor for external connection is drawn outside, and said 2nd metallic material is continuously formed in the field by the side of said base material of said flexible plate from the part of said thermocouple. In the field by the side of said base material of said flexible plate The 2nd electric conduction film for wiring which extends to said end face side field while connecting with said 2nd metallic material electrically is formed. Between said flexible plates and said base materials It intervenes so that a part of 2nd conductor for external connection may be electrically connected with said 2nd electric conduction film for wiring, and said a part of other 2nd conductor for external connection is drawn outside.
[0029] Said 2nd metallic material may be prolonged as it is, what may consist of different ingredients and added two or more film one by one is sufficient as said 2nd metallic material, and the film which consists of two or more layers is sufficient as said 2nd electric conduction film for wiring.
[0030] This 5th mode is the example of said 1st mode, and is an example using what forms the 2nd metallic material in a base material side as well as the 1st metallic material to a flexible plate, and consists of an insulating material as a base material further. A 1st [of a thermocouple] metallic material side can be connected outside through the 1st electric conduction film for wiring, and the 1st conductor for external connection, and a 2nd [of a thermocouple] metallic material side can be connected outside through the 2nd electric conduction film for wiring, and the 2nd conductor for external connection. In addition, since not only the 1st metallic material but the 2nd metallic material is formed in the base material side of a flexible plate, before removing the substrate which is in the middle of manufacture, is used at the time of manufacture, and is removed at the end at it, it can be formed. Therefore, area of a thermocouple can be made small, while being able to adopt the accurate film formation technique in which aligners, such as the lift-off method, were used, not only in the 1st metallic material but in the case of film formation of the 2nd metallic material and being able to form the magnitude and the location of a both lap part, i.e., a thermocouple, with a very sufficient precision at it.
[0031] the 6th voice of this invention -- the cantilever depended like -- said 5th voice -- in the cantilever depended like, each of said 1st and 2nd conductors for external connection is the electric conduction film for wiring formed in the field which does not lap with said

flexible plate from the field which laps with said flexible plate in the field by the side of said flexible plate of said base material, having covered.

[0032] Although the 1st and 2nd conductors for external connection may be conductors, such as a metallic foil and a metal wire, in said 5th mode like said 6th mode If the electric conduction film for wiring formed in the field of a base material is used as 1st and 2nd conductors for external connection For example, the cantilever concerned can be mass-produced using the batch process using a semi-conductor manufacturing technology like the manufacture approach by the 10th mode mentioned later, and the cantilever concerned can be offered cheaply.

[0033] the 7th voice of this invention -- the cantilever depended like -- said 1st [the], the 3rd, or the 6th one of voice -- in the cantilever depended like, said base material consists of a glass member containing movable ion, and said flexible plate and said base material are joined by anode plate junction.

[0034] Like this 7th mode, when anode plate junction is adopted, junction between a flexible plate and a base material becomes easy, and it is desirable.

[0035] The cantilever by the 8th mode of this invention is the approach of manufacturing the cantilever by said 4th mode. (1) It is the structure which has a substrate, the thin film formed in this substrate front face, and the 1st metal membrane. While patterning of said thin film is carried out according to the configuration of said flexible plate, it has opening in the location corresponding to said probe. It has a crevice for said substrate to imprint the configuration of said probe under said opening of said thin film. The process by which extended on said thin film from this field, and patterning was carried out according to the configuration of said 1st electric conduction film for wiring while said 1st metal membrane was formed in the wrap field in said crevice and which prepares the structure, (2) The process which prepares the insulating member by which the 2nd metal membrane by which patterning was carried out according to the configuration of said 1st conductor for external wiring was formed in the inferior surface of tongue, (3) Alignment of said structure and said insulating member is carried out so that said a part of 1st metal membrane and said a part of 2nd metal membrane may lap and contact. the process which joins the inferior surface of tongue of said insulating member to the top face of said thin film, and (4) -- the process which removes said substrate, and (5) -- it has the process which forms the 3rd metal membrane in the near predetermined field to which said substrate in the structure which remained after removal of said substrate existed.

[0036] The manufacture approach of the cantilever by the 9th mode of this invention In the manufacture approach by said 8th mode, said process which prepares said structure The process which forms a thin film in said substrate front face, and the process which forms said opening in this thin film, The process which etches the part of said substrate exposed from the opening concerned, and forms the trench as said crevice in the bottom of the opening concerned in said substrate, While said crevice is located in the wrap aforementioned field, it has the process which forms said 1st metal membrane by which patterning was carried out according to the configuration of said 1st electric conduction film for wiring so that it might extend on said thin film from the field concerned.

[0037] The manufacture approach of the cantilever by the 10th mode of this invention It is the approach of manufacturing the cantilever by said 6th mode, and is the structure which has (1) substrate, the thin film formed in this substrate front face, and the 1st and 2nd metal membranes. While patterning of said thin film is carried out according to the configuration of said flexible plate, it has opening in the location corresponding to said probe. It has a crevice for said substrate to imprint the configuration of said probe under said opening of said thin film. While said 1st metal membrane is formed in a wrap field in said crevice, extend on said thin film from this field, and patterning is carried out according to the configuration of said 1st electric conduction film for wiring. The process by which extended on said thin film from the lap field concerned, and patterning was carried out according to the configuration of said 2nd electric conduction film for wiring while being formed so that said 2nd metal membrane might lap with said 1st metal membrane in said crevice and which prepares the structure, (2) The process which prepares the insulating member by which the 3rd and 4th metal membranes by which patterning was carried out respectively according to the configuration of said 1st and 2nd conductors for external wiring were formed in the inferior surface of tongue, (3) Alignment of said structure and said insulating member is carried out so that said a part of 2nd metal membrane and said a part of 4th metal membrane may lap and contact, while said a part of 1st metal membrane and said a part of 3rd metal membrane lap and contact. the process which joins the inferior surface of tongue of said insulating member to the top face of said thin film, and (4) -- it has the process which removes said substrate.

[0038] The manufacture approach of the cantilever by the 11th mode of this invention In the manufacture approach by said 10th mode, said process which prepares said structure The process which forms a thin film in said substrate front face, and the process which forms said opening in this thin film, The process which etches the part of said substrate exposed from the opening concerned, and forms the trench as said crevice in the bottom of the opening concerned in said substrate, The process which forms said 1st metal membrane by which patterning was carried out according to the configuration of said 1st electric conduction film for wiring so that it might extend on said thin film from the field concerned while said crevice is located in the wrap aforementioned field, The process which forms said 1st metal membrane by which patterning was carried out according to the configuration of said 1st electric conduction film for wiring so that it might extend on said thin film from the field concerned while said crevice is located in the wrap aforementioned field, While being located so that it may lap with said 1st metal membrane in said crevice, it has the process which forms said 2nd metal membrane by which patterning was carried out according to the configuration of said 2nd electric conduction film for wiring so that it might extend on said thin film from the lap field concerned.

[0039] the 12th voice of this invention -- the manufacture approach of the cantilever depended like -- said 9th or 11th voice -- in the manufacture approach depended like, said process which prepares said structure has the process which makes the wall of said trench of said substrate make it steep by thermal oxidation before said process which is after said process which forms said trench, and forms said 1st metal membrane.

[0040] the 13th voice of this invention -- the manufacture approach of the cantilever depended like -- said voice of either the 8th thru/or the 12th either -- in the manufacture approach depended like, said insulating member consists of a glass member containing movable ion, and said process to join is a process which carries out anode plate junction of the inferior surface of tongue of said insulating member on the top face of said thin film.

[0041] The manufacture approach by said the 8th thru/or 13th mode is an example of the manufacture approach of the cantilever by said 4th or 6th mode, respectively. A cantilever can be manufactured according to the batch process using a semi-conductor manufacturing technology, and any manufacture approach can be mass-produced and can manufacture a cantilever cheaply. It is desirable, when it has the process which makes the wall of said trench of a substrate make it steep by thermal oxidation like said 12th mode, and it can be further radicalized in the point of a probe and the resolution of measurement is raised. Like said 13th mode, when

anode plate junction is used for junction between an insulating member and a thin film, the junction becomes easy and it is desirable.
[0042]
[Embodiment of the Invention] Hereafter, the cantilever by this invention and its manufacture approach are explained to a detail with reference to a drawing.
[0043] First, the cantilever by the gestalt of operation of the 1st of this invention is explained with reference to drawing 1 . The cantilever by the gestalt of this operation is constituted as a cantilever for microscopes which attains both the functions of a scan mold heat measurement microscope and a scan mold atomic force microscope.
[0044] The outline perspective view showing the cantilever according [drawing 1 (a)] to the gestalt of this operation and drawing 1 (b) are the outline sectional views which met the C-C line in drawing 1 (a). In addition, although the upper and lower sides are conversely shown by drawing 1 (a) and drawing 1 (b), in the following explanation, the upper and lower sides shall follow drawing 1 (b).
[0045] The cantilever by the gestalt of this operation is equipped with the flexible plate 41 which consists of an insulating material, the probe 42 which protruded on the inferior surface of tongue of the tip side field of this flexible plate 41, and the base material 43 which consists of an insulating material joined to the top face of the end face side field of the flexible plate 41 as shown in drawing 1 . Therefore, the probe 42 and the base material 3 are projected to the opposite direction to the flexible plate 41.
[0046] The probe 42 consists of metal membranes (metallic material) 44 and 45 of a different class, and junction of the metal membranes 44 and 45 in the probe 42 concerned constitutes the thermocouple from a gestalt of this operation. But by this invention, the whole probe 42 does not need to consist of metal membranes 44 and 45, and you may consist of metal membranes of the class from which a part of probe 42 differs. In addition, the metal membrane 44 is caudad projected from opening formed in the part corresponding to a probe 42 in the flexible plate 41.
[0047] Said metal membrane 44 is continuously formed in the top face (field by the side of a base material 43) of the flexible plate 41 from the part of a thermocouple. Moreover, while connecting with a metal membrane 44 electrically, the electric conduction film 46 for wiring which extends to the end face side field of the flexible plate 41 is formed in the top face of the flexible plate 41. The electric conduction film 46 for wiring consists of gestalten of this operation as that to which the metal membrane 44 extended as it is. But what may consist of different metallic materials from a metal membrane 44, and added two or more film is sufficient as the electric conduction film 46 for wiring, and it may be film which consists of two or more layers.
[0048] Said metal membrane 45 is continuously formed in the inferior surface of tongue (near field of a probe 42) of the flexible plate 41 from the part of said thermocouple. Moreover, while connecting with a metal membrane 45 electrically, the electric conduction film 47 for wiring which extends to the end face side field of the flexible plate 41 is formed in the inferior surface of tongue of the flexible plate 41. The electric conduction film 47 for wiring consists of gestalten of this operation as that to which the metal membrane 45 extended as it is. But what may consist of different metallic materials from a metal membrane 45, and added two or more film is sufficient as the electric conduction film 47 for wiring, and it may be film which consists of two or more layers.
[0049] The electric conduction film 48 for wiring which consists of a metal membrane which is missing from the field which does not lap with the flexible plate 41, and extends is formed in the inferior surface of tongue (field by the side of the flexible plate 41) of a base material 43 from the field which laps with the flexible plate 41. The part of the edge in said field of the electric conduction film 48 for wiring with which it does not lap is electrode pad section 48a for electrical installation with the exterior. While this electric conduction film 48 for wiring intervenes so that a part may be electrically connected with the electric conduction film 46 for wiring, other parts constitute the conductor for external connection drawn outside from a gestalt of this operation. But in this invention, conductors, such as a metallic foil and a metal wire, may be used as the conductor for external connection concerned.
[0050] And the flexible plate 41 and the base material 43 are joined so that the electric conduction film 46 for wiring and the electric conduction film 48 for wiring may contact and it may connect electrically. With the gestalt of this operation, a base material 43 consists of a glass ingredient (for example, boro-silicated glass) containing movable ion, and the flexible plate 41 and the base material 43 are joined by anode plate junction. But in this invention, a base material 43 may be constituted from other insulating materials, and the junction between the flexible plate 41 and a base material 43 is not necessarily limited to anode plate junction. In addition, specifically as a glass ingredient which was mentioned above, Pyrex glass (trade name) can be mentioned. In addition, although what consists of an insulating material as a base material 43 in this way is used with the gestalt of this operation, what consists of electrical conducting materials, such as a metal, as a base material 43 may be used in this invention. In this case, the electric conduction film 48 for wiring is removed, and the flexible plate 41 and the electric conduction film 46 for wiring are joined so that a base material 43 and the electric conduction film 46 for wiring may be connected electrically.
[0051] Next, an example of the manufacture approach of the cantilever shown in drawing 1 is explained with reference to drawing 2 . Drawing 2 is the outline sectional view showing an example of the production process of the cantilever shown in drawing 1 .
[0052] first -- as a substrate ingredient (100) -- the silicon substrate 50 with a diameter [of field bearing / of 3 inches], and a thickness of 250 micrometers -- using -- LPCVD -- the silicon nitride films 51 and 52 with a thickness of 700nm are formed to both sides of a substrate 50 by law (reduced pressure CVD method) etc. (a silicon nitride film 51 is equivalent to the flexible plate 41 in drawing 1). Next, opening 51a of the shape of a square to which the front face of a substrate 50 is exposed is formed in the predetermined part of a silicon nitride film 51 by carrying out patterning of the silicon nitride film 51 on top using the lithography method and the dry etching method. In this example, two or more cantilevers are manufactured to coincidence, and only the number corresponding to the number of the cantilevers which opening 51a tends to manufacture to coincidence is formed. In addition, the pattern configuration of opening 51a, magnitude, and quantity can be set as arbitration. Next, this substrate is immersed in the etching reagent for silicon, such as a potassium-hydroxide (KOH) water solution or a tetramethylammonium hydroxide (TMAH) water solution, silicon nitride films 51 and 52 are used as a mask, anisotropic etching of the part of the substrate 50 exposed from opening 51a is carried out, and trench 50a is formed in the bottom of opening 51a (drawing 2 (a)). Trench 50a is constituted by the silicon (111) side, and becomes a square drill-like crevice. In this example, it becomes a crevice for trench 50a to imprint the configuration of said probe 42.
[0053] Next, while carrying out patterning of the silicon nitride film 51 on top according to the configuration of the flexible plate 41 using the lithography method and the dry etching method, the silicon nitride film 52 at the bottom is removed (drawing 2 (b)).
[0054] Then, patterning of the metal membrane 53 (equivalent to the metal membrane 44 in drawing 1) is carried out to the field which is equivalent to a wrap field and the electric conduction film 46 for wiring in trench 50a on the substrate of the condition which shows in drawing 2 (b) by the lift-off method (drawing 2 (c)). Nichrome (NiCr) can be used as a metal membrane 53.

[0055] In addition, the process which removes a silicon nitride film 52 while carrying out patterning of the silicon nitride film 51 explained with reference to drawing 2 (b), and the process which forms the metal membrane 53 explained with reference to drawing 2 (c) may be performed by the reverse order.
[0056] Although the above process constitutes the process which prepares the structure shown in drawing 2 (c), the process which prepares the structure shown in drawing 2 (c) is not necessarily limited to what is depended on such each process.
[0057] The Pyrex glass member 55 (equivalent to the base material 43 in drawing 1) by which the metal membranes 54 (equivalent to the electric conduction film 48 for wiring), such as gold by which patterning was carried out according to the configuration of said electric conduction film 48 for wiring, were formed in the inferior surface of tongue on the other hand is prepared (drawing 2 (d)). With the gestalt of this operation, slot 55a for avoiding that a tabular thing is used as a Pyrex glass member 55, and a garbage is joined by the anode plate junction mentioned later is beforehand formed in the inferior surface of tongue of processing by the dicing saw. If it puts in another way, a bridge is constructed over between the parts which should serve as said two or more base materials 43 for a cantilever by the part in which slot 55a is formed, and the Pyrex glass member 55 is making tabular as a whole. In addition, the slot for separation (not shown) is formed in the part in which slot 55a is formed.
[0058] Next, alignment of said structure and said Pyrex glass member 55 is carried out so that a part of metal membrane 53 of the structure shown in drawing 2 (c) and a part of metal membrane 54 of the inferior surface of tongue of said Pyrex glass member 55 may lap and contact, and anode plate junction of the inferior surface of tongue of the Pyrex glass member 55 is carried out on the top face of the silicon nitride film 51 of said structure (drawing 2 (d)). At this time, a part of metal membrane 53 and a part of metal membrane 54 will be stuck by pressure, and it will connect electrically.
[0059] Subsequently, the part in which said slot 55 in the Pyrex glass member 55 is formed is excised by processing by the dicing saw. However, said excision is not performed about the edges of the train in which said slot for separation is formed, and each train. Next, the structure of this condition is immersed in a KOH water solution or a TMAH water solution, and a substrate 50 is removed. Since there is nothing a limping gait crack completely as said excision mentioned above, each cantilever is connected also in this condition (that connection condition is not shown in drawing 2 .). Subsequently, the metal membranes 58 (equivalent to the metal membrane 45 in drawing 1), such as Ti with a thickness of about 50nm, are partially formed by vacuum evaporationo etc. by using a metal sheet with opening as a masking object to the probe side of the structure of this condition (drawing 2 (e)). Finally, it separates into each cantilever using said slot for separation. Thereby, the cantilever shown in drawing 1 is completed. But a cantilever [being connected] is supplied to a measurement person and a measurement person may be made to separate into each cantilever using said slot for separation.
[0060] It will be decided by the cantilever shown in drawing 1 in the magnitude and the location of opening 51a of a silicon nitride film 51 which were formed on the substrate 50 which the magnitude and the location of a thermocouple mentioned above so that the explanation mentioned above may show. The opening 51a concerned can be formed using the lithography method (an aligner is used) and the dry etching method, as mentioned above. For this reason, while being able to form the magnitude and the location of said opening 51a with a very sufficient precision, it is possible to make area of opening 51a small. Therefore, area of a thermocouple can be made small while being able to form the magnitude and the location of a thermocouple with a very sufficient precision. Consequently, in the cantilever shown in drawing 1 , the precision and resolution of measurement of the temperature distribution on the front face of a sample or thermal conductivity distribution become high.
[0061] Moreover, in the cantilever shown in drawing 1 , the probe 42 and the base material 43 have projected to the opposite direction to the flexible plate 41. Therefore, like the case of drawing 10 (b), the part (namely, lever section) to which the base material 43 in the flexible play 41 is not joined can be shortened, resonance frequency of the cantilever concerned can be made high, and rapid scanning can be realized so that the corner of a base material 43 may not hit a sample at the time of measurement.
[0062] Furthermore, in the cantilever shown in drawing 1 , the cantilever concerned can be mass-produced using the batch process using a semi-conductor manufacturing technology which was explained with reference to drawing 2 , and the cantilever concerned can be offered cheaply.
[0063] Next, other examples of the manufacture approach of the cantilever shown in drawing 1 are explained with reference to drawing 3 . Drawing 3 is the outline sectional view showing other examples of the production process of the cantilever shown in drawing 1 . In drawing 3 , the same sign is given to the same as that of the element in drawing 2 , or a corresponding element.
[0064] first -- as a substrate ingredient (100) -- the silicon substrate 50 with a diameter [of field bearing / of 3 inches], and a thickness of 250 micrometers -- using -- LPCVD -- the silicon nitride films 51 and 52 with a thickness of 700nm are formed to both sides of a substrate 50 by law (reduced pressure CVD method) etc. (a silicon nitride film 51 is equivalent to the flexible plate 41 in drawing 1). Next, opening 51a of the shape of a square to which the front face of a substrate 50 is exposed is formed in the predetermined part of a silicon nitride film 51 by carrying out patterning of the silicon nitride film 51 on top using the lithography method and the dry etching method. Also in this example, two or more cantilevers are manufactured to coincidence, and only the number corresponding to the number of the cantilevers which opening 51a tends to manufacture to coincidence is formed. In addition, the pattern configuration of opening 51a, magnitude, and quantity can be set as arbitration. Next, this substrate is immersed in the etching reagent for silicon, such as a potassium-hydroxide (KOH) water solution or a tetramethylammonium hydroxide (TMAH) water solution, silicon nitride films 51 and 52 are used as a mask, anisotropic etching of the part of the substrate 50 exposed from opening 51a is carried out, and trench 50a is formed in the bottom of opening 51a (drawing 3 (a)). Trench 50a is constituted by the silicon (111) side, and becomes a square drill-like crevice. In this example, trench 50a is constituted by the silicon (111) side, and becomes a square drill-like crevice.
[0065] Subsequently, heat the substrate of the condition which shows in drawing 3 (a) in an oxygen ambient atmosphere, the wall of trench 50a of the exposed substrate 50 is made to oxidize thermally (thermal oxidation of which format, such as wet oxidation and dry oxidation, is sufficient), and the oxidation silicon film 56 is formed (drawing 3 (b)). Since oxidization progresses late in the corner section of a silicon crystal, it becomes steep especially near the pars basilaris ossis occipitalis of trench 50a (i.e., the point of a square drill). In this example, it becomes a crevice for this trench 50a made steep to imprint the configuration of a probe 42.
[0066] Next, while carrying out patterning of the silicon nitride film 51 on top according to the configuration of the flexible plate 41 using the lithography method and the dry etching method, the silicon nitride film 52 at the bottom is removed (drawing 3 (c)).
[0067] Then, patterning of the metal thin film 53 (equivalent to the metal membrane 44 in drawing 1) is carried out to the field which is equivalent to a wrap field and the electric conduction film 46 for wiring in trench 50a on the substrate of the condition which shows in

drawing 3 (c) made steep by the lift-off method (drawing 3 (d)).
[0068] Although the above process constitutes the process which prepares the structure shown in drawing 3 (d), the process which prepares the structure shown in drawing 3 (d) is not necessarily limited to what is depended on such each process.
[0069] The Pyrex glass member 55 (equivalent to the base material 43 in drawing 1) by which the metal membranes 54 (equivalent to the electric conduction film 48 for wiring), such as gold by which patterning was carried out according to the configuration of said electric conduction film 48 for wiring, were formed in the inferior surface of tongue on the other hand is prepared (drawing 3 (e)). With the gestalt of this operation, slot 55a for avoiding that a tabular thing is used as a Pyrex glass member 55, and a garbage is joined by the anode plate junction mentioned later is beforehand formed in the inferior surface of tongue of processing by the dicing saw. If it puts in another way, a bridge is constructed over between the parts which should serve as said two or more base materials 43 for a cantilever by the part in which slot 55a is formed, and the Pyrex glass member 55 is making tabular as a whole. In addition, the slot for separation (not shown) is formed in the part in which slot 55a is formed.
[0070] Next, alignment of said structure and said Pyrex glass member 55 is carried out so that a part of metal membrane 53 of the structure shown in drawing 3 (d) and a part of metal membrane 54 of the inferior surface of tongue of said Pyrex glass member 55 may lap and contact, and anode plate junction of the inferior surface of tongue of the Pyrex glass member 55 is carried out on the top face of the silicon nitride film 51 of said structure (drawing 3 (e)). At this time, a part of metal membrane 53 and a part of metal membrane 54 will be stuck by pressure, and it will connect electrically.
[0071] Subsequently, the part in which said slot 55 in the Pyrex glass member 55 is formed is excised by processing by the dicing saw. However, said excision is not performed about the edges of the train in which said slot for separation is formed, and each train. Then, the structure of this condition is immersed in a KOH water solution or a TMAH water solution, and a substrate 50 and the oxidation silicon film 56 are removed. Since there is nothing a limping gait crack completely as said excision mentioned above, each cantilever is connected also in this condition (that connection condition is not shown in drawing 2 .). Next, the metal membranes 58 (equivalent to the metal membrane 45 in drawing 1), such as Ti with a thickness of about 50nm, are partially formed by vacuum evaporationo etc. by using a metal sheet with opening as a masking object to the probe side of the structure of this condition (drawing 3 (f)). Finally, it separates into each cantilever using said slot for separation. Thereby, the cantilever shown in drawing 1 is completed. But a cantilever [being connected] is supplied to a measurement person and a measurement person may be made to separate into each cantilever using said slot for separation.
[0072] In the cantilever obtained by the manufacture approach explained with reference to drawing 3 , since the crevice for imprinting the configuration of a probe 2 is set to trench 50a made steep, compared with the cantilever manufactured by the manufacture approach explained with reference to drawing 2 , the point of a probe 43 is further radicalized and the resolution of measurement improves.
[0073] Next, the cantilever by the gestalt of operation of the 2nd of this invention is explained with reference to drawing 4 . The cantilever by the gestalt of this operation is also constituted as a cantilever for microscopes which attains both the functions of a scan mold heat measurement microscope and a scan mold atomic force microscope.
[0074] The outline perspective view showing the cantilever according [drawing 4 (a)] to the gestalt of this operation and drawing 4 (b) are the outline sectional views in alignment with D-D line in drawing 4 (a). In addition, although the upper and lower sides are conversely shown by drawing 4 (a) and drawing 4 (b), in the following explanation, the upper and lower sides shall follow drawing 4 (b). In drawing 4 , the same sign is given to the same as that of the element in drawing 1 , or a corresponding element, and the duplicate explanation is omitted.
[0075] The places where the cantilever by the gestalt of this operation differs from the cantilever shown in drawing 1 are the following points.
[0076] With the gestalt of this operation, the metal membrane 45 (therefore, also electric conduction film 47 for wiring) in drawing 1 is removed, and the metal membrane 145 of a class which is different in a metal membrane 44, the electric conduction film 147 for wiring, and the electric conduction film 148 for wiring are added instead.
[0077] That is, the probe 42 consists of said metal membrane 44 and a metal membrane 145 formed on this metal membrane 44, and junction of the metal membrane 44,145 in the probe 42 concerned constitutes the thermocouple. The metal membrane 145 has lapped with the metal membrane 44 only in the part of a probe 42. The metal membrane 145 is continuously formed in the top face (field by the side of a base material 43) of the flexible plate 41 from the part of a thermocouple. Moreover, while connecting with a metal membrane 145 electrically, said electric conduction film 147 for wiring which extends to the end face side field of the flexible plate 41 is formed in the top face of the flexible plate 41. The electric conduction film 147 for wiring consists of gestalten of this operation as that to which the metal membrane 145 extended as it is. But what may consist of different metallic materials from a metal membrane 145, and added two or more film is sufficient as the electric conduction film 147 for wiring, and it may be film which consists of two or more layers.
[0078] The electric conduction film 148 for wiring which consists of a metal membrane which is missing from the field which does not lap with the flexible plate 41, and extends is formed in the inferior surface of tongue (field by the side of the flexible plate 41) of a base material 43 from the field which laps with the flexible plate 41. The part of the edge in said field of the electric conduction film 148 for wiring with which it does not lap is electrode pad section 148a for electrical installation with the exterior. While this electric conduction film 148 for wiring intervenes so that a part may be electrically connected with the electric conduction film 147 for wiring, other parts constitute the conductor for external connection drawn outside from a gestalt of this operation. But in this invention, conductors, such as a metallic foil and a metal wire, may be used as the conductor for external connection concerned.
[0079] And the flexible plate 41 and the base material 43 are joined so that the electric conduction film 147 for wiring and the electric conduction film 148 for wiring may contact and it may connect electrically. With the gestalt of this operation, a base material 43 consists of a glass ingredient (for example, boro-silicated glass) containing movable ion, and the flexible plate 41 and the base material 43 are joined by anode plate junction. But in this invention, a base material 43 may be constituted from other insulating materials, and the junction between the flexible plate 41 and a base material 43 is not necessarily limited to anode plate junction.
[0080] Next, an example of the manufacture approach of the cantilever shown in drawing 4 is explained with reference to drawing 5 . Drawing 5 is the outline sectional view showing an example of the production process of the cantilever shown in drawing 4 . In drawing 5 , the same sign is given to the same as that of the element in drawing 2 , or a corresponding element.
[0081] first -- as a substrate ingredient (100) -- the silicon substrate 50 with a diameter [of field bearing / of 3 inches], and a

thickness of 250 micrometers -- using -- LPCVD -- the silicon nitride films 51 and 52 with a thickness of 700nm are formed to both sides of a substrate 50 by law (reduced pressure CVD method) etc. (a silicon nitride film 51 is equivalent to the flexible plate 41 in drawing 4). Next, opening 51a of the shape of a square to which the front face of a substrate 50 is exposed is formed in the predetermined part of a silicon nitride film 51 by carrying out patterning of the silicon nitride film 51 on top using the lithography method and the dry etching method. In this example, two or more cantilevers are manufactured to coincidence, and only the number corresponding to the number of the cantilevers which opening 51a tends to manufacture to coincidence is formed. In addition, the pattern configuration of opening 51a, magnitude, and quantity can be set as arbitration. Next, this substrate is immersed in the etching reagent for silicon, such as a potassium-hydroxide (KOH) water solution or a tetramethylammonium hydroxide (TMAH) water solution, silicon nitride films 51 and 52 are used as a mask, anisotropic etching of the part of the substrate 50 exposed from opening 51a is carried out, and trench 50a is formed in the bottom of opening 51a (drawing 5 (a)). Trench 50a is constituted by the silicon (111) side, and becomes a square drill-like crevice. In this example, it becomes a crevice for trench 50a to imprint the configuration of said probe 42.

[0082] Next, while carrying out patterning of the silicon nitride film 51 on top according to the configuration of the flexible plate 41 using the lithography method and the dry etching method, the silicon nitride film 52 at the bottom is removed (drawing 5 (b)).

[0083] Then, patterning of the metal membranes 53 (equivalent to the metal membrane 44 in drawing 4), such as Nichrome (NiCr), is carried out to the field which is equivalent to a wrap field and the electric conduction film 46 for wiring in trench 50a on the substrate of the condition which shows in drawing 5 (b) by the lift-off method. Subsequently, patterning of the metal membranes 245 (equivalent to the metal membrane 145 in drawing 4), such as Ti, is carried out to the field equivalent to said electric conduction film 147 for wiring which extends on a silicon nitride film 51 from the field which laps with a metal membrane 53 in trench 50a on the substrate of this condition, and the lap field concerned by the lift-off method (drawing 5 (c)).

[0084] Although the above process constitutes the process which prepares the structure shown in drawing 5 (c), the process which prepares the structure shown in drawing 5 (c) is not necessarily limited to what is depended on such each process.

[0085] The Pyrex glass member 55 (equivalent to the base material 43 in drawing 4) by which the metal membranes 54 (equivalent to the electric conduction film 48,148 for wiring), such as gold by which patterning was carried out according to the configuration of said electric conduction film 48,148 for wiring, were formed in the inferior surface of tongue on the other hand is prepared (drawing 5 (d)). With the gestalt of this operation, slot 55a for avoiding that a tabular thing is used as a Pyrex glass member 55, and a garbage is joined by the anode plate junction mentioned later is beforehand formed in the inferior surface of tongue of processing by the dicing saw. If it puts in another way, a bridge is constructed over between the parts which should serve as said two or more base materials 43 for a cantilever by the part in which slot 55a is formed, and the Pyrex glass member 55 is making tabular as a whole. In addition, the slot for separation (not shown) is formed in the part in which slot 55a is formed.

[0086] Next, while a part of metal membrane 53 of the structure shown in drawing 5 (c) and a part of metal membrane 54 of the inferior surface of tongue of said Pyrex glass member 55 lap and contact So that a part of metal membrane 245 of the structure shown in drawing 5 (c) and a part of other metal membranes 54 of the inferior surface of tongue of said Pyrex glass member 55 may lap and contact Alignment of said structure and said Pyrex glass member 55 is carried out, and anode plate junction of the inferior surface of tongue of the Pyrex glass member 55 is carried out on the top face of the silicon nitride film 51 of said structure (drawing 5 (d)). While a part of metal membrane 53 and a part of metal membrane 54 are stuck by pressure and connecting electrically at this time, a part of metal membrane 245 and a part of other metal membranes 54 will be stuck by pressure, and it will connect electrically.

[0087] Subsequently, the part in which said slot 55 in the Pyrex glass member 55 is formed is excised by processing by the dicing saw. However, said excision is not performed about the edges of the train in which said slot for separation is formed, and each train. Next, the structure of this condition is immersed in a KOH water solution or a TMAH water solution, and a substrate 50 is removed. Since there is nothing a limping gait crack completely as said excision mentioned above, each cantilever is connected also in this condition (that connection condition is not shown in drawing 5.). Finally, it separates into each cantilever using said slot for separation. Thereby, the cantilever shown in drawing 4 is completed. But a cantilever [being connected] is supplied to a measurement person and a measurement person may be made to separate into each cantilever using said slot for separation.

[0088] In the cantilever shown in drawing 4, while being able to adopt the accurate film formation technique in which aligners, such as the lift-off method, were used, in the case of film formation of a metal membrane 46,145 (namely, metal membrane 53,245) and being able to form the magnitude and the location of a both lap part, i.e., a thermocouple, with a very sufficient precision at it so that the explanation mentioned above may show, area of a thermocouple can be made small. Therefore, area of a thermocouple can be made small while being able to form the magnitude and the location of a thermocouple with a very sufficient precision. Consequently, in the cantilever shown in drawing 4, the precision and resolution of measurement of the temperature distribution on the front face of a sample or thermal conductivity distribution become high.

[0089] Moreover, in the cantilever shown in drawing 4, the probe 42 and the base material 43 have projected to the opposite direction to the flexible plate 41. Therefore, like the case of drawing 10 (b), the part (namely, lever section) to which the base material 43 in the flexible play 41 is not joined can be shortened, resonance frequency of the cantilever concerned can be made high, and rapid scanning can be realized so that the corner of a base material 43 may not hit a sample at the time of measurement.

[0090] Furthermore, in the cantilever shown in drawing 4, the cantilever concerned can be mass-produced using the batch process using a semi-conductor manufacturing technology which was explained with reference to drawing 5, and the cantilever concerned can be offered cheaply.

[0091] Next, other examples of the manufacture approach of the cantilever shown in drawing 4 are explained with reference to drawing 6. Drawing 6 is the outline sectional view showing other examples of the production process of the cantilever shown in drawing 4. In drawing 6, the same sign is given to the same as that of the element in drawing 5, or a corresponding element.

[0092] first -- as a substrate ingredient (100) -- the silicon substrate 50 with a diameter [of field bearing / of 3 inches], and a thickness of 250 micrometers -- using -- LPCVD -- the silicon nitride films 51 and 52 with a thickness of 700nm are formed to both sides of a substrate 50 by law (reduced pressure CVD method) etc. (a silicon nitride film 51 is equivalent to the flexible plate 41 in drawing 4). Next, opening 51a of the shape of a square to which the front face of a substrate 50 is exposed is formed in the predetermined part of a silicon nitride film 51 by carrying out patterning of the silicon nitride film 51 on top using the lithography method and the dry etching method. Also in this example, two or more cantilevers are manufactured to coincidence, and only the number corresponding to the number of the cantilevers which opening 51a tends to manufacture to coincidence is formed. In addition,

the pattern configuration of opening 51a, magnitude, and quantity can be set as arbitration. Next, this substrate is immersed in the etching reagent for silicon, such as a potassium-hydroxide (KOH) water solution or a tetramethylammonium hydroxide (TMAH) water solution, silicon nitride films 51 and 52 are used as a mask, anisotropic etching of the part of the substrate 50 exposed from opening 51a is carried out, and trench 50a is formed in the bottom of opening 51a (drawing 6 (a)). Trench 50a is constituted by the silicon (111) side, and becomes a square drill-like crevice. In this example, trench 50a is constituted by the silicon (111) side, and becomes a square drill-like crevice.

[0093] Subsequently, heat the substrate of the condition which shows in drawing 6 (a) in an oxygen ambient atmosphere, the wall of trench 50a of the exposed substrate 50 is made to oxidize thermally (thermal oxidation of which format, such as wet oxidation and dry oxidation, is sufficient), and the oxidation silicon film 56 is formed (drawing 6 (b)). Since oxidization progresses late in the corner section of a silicon crystal, it becomes steep especially near the pars basilaris ossis occipitalis of trench 50a (i.e., the point of a square drill). In this example, it becomes a crevice for this trench 50a made steep to imprint the configuration of a probe 42.

[0094] Next, while carrying out patterning of the silicon nitride film 51 on top according to the configuration of the flexible plate 41 using the lithography method and the dry etching method, the silicon nitride film 52 at the bottom is removed (drawing 6 (c)).

[0095] Then, patterning of the metal thin films 53 (equivalent to the metal membrane 44 in drawing 4), such as Nichrome (NiCr), is carried out to the field which is equivalent to a wrap field and the electric conduction film 46 for wiring in trench 50a on the substrate of the condition which shows in drawing 6 (c) made steep by the lift-off method. Subsequently, patterning of the metal membranes 245 (equivalent to the metal membrane 145 in drawing 4), such as Ti, is carried out to the field equivalent to said electric conduction film 147 for wiring which extends on a silicon nitride film 51 from the field which laps with a metal membrane 53 in trench 50a on the substrate of this condition made steep, and the lap field concerned by the lift-off method (drawing 6 (d)).

[0096] Although the above process constitutes the process which prepares the structure shown in drawing 6 (d), the process which prepares the structure shown in drawing 3 (d) is not necessarily limited to what is depended on such each process.

[0097] The Pyrex glass member 55 (equivalent to the base material 43 in drawing 4) by which the metal membranes 54 (equivalent to the electric conduction film 48,148 for wiring), such as gold by which patterning was carried out according to the configuration of said electric conduction film 48,148 for wiring, were formed in the inferior surface of tongue on the other hand is prepared (drawing 6 (e)). With the gestalt of this operation, slot 55a for avoiding that a tabular thing is used as a Pyrex glass member 55, and a garbage is joined by the anode plate junction mentioned later is beforehand formed in the inferior surface of tongue of processing by the dicing saw. If it puts in another way, a bridge is constructed over between the parts which should serve as said two or more base materials 43 for a cantilever by the part in which slot 55a is formed, and the Pyrex glass member 55 is making tabular as a whole. In addition, the slot for separation (not shown) is formed in the part in which slot 55a is formed.

[0098] Next, while a part of metal membrane 53 of the structure shown in drawing 6 (d) and a part of metal membrane 54 of the inferior surface of tongue of said Pyrex glass member 55 lap and contact So that a part of metal membrane 245 of the structure shown in drawing 6 (d) and a part of other metal membranes 54 of the inferior surface of tongue of said Pyrex glass member 55 may lap and contact Alignment of said structure and said Pyrex glass member 55 is carried out, and anode plate junction of the inferior surface of tongue of the Pyrex glass member 55 is carried out on the top face of the silicon nitride film 51 of said structure (drawing 6 (e)). While a part of metal membrane 53 and a part of metal membrane 54 are stuck by pressure and connecting electrically at this time, a part of metal membrane 245 and a part of other metal membranes 54 will be stuck by pressure, and it will connect electrically.

[0099] Subsequently, the part in which said slot 55 in the Pyrex glass member 55 is formed is excised by processing by the dicing saw. However, said excision is not performed about the edges of the train in which said slot for separation is formed, and each train. Next, the structure of this condition is immersed in a KOH water solution or a TMAH water solution, and a substrate 50 is removed. Since there is nothing a limping gait crack completely as said excision mentioned above, each cantilever is connected also in this condition (that connection condition is not shown in drawing 6.). Finally, it separates into each cantilever using said slot for separation. Thereby, the cantilever shown in drawing 4 is completed. But a cantilever [being connected] is supplied to a measurement person and a measurement person may be made to separate into each cantilever using said slot for separation.

[0100] In the cantilever obtained by the manufacture approach explained with reference to drawing 6, since the crevice for imprinting the configuration of a probe 2 is set to trench 50a made steep, compared with the cantilever manufactured by the manufacture approach explained with reference to drawing 5, the point of a probe 43 is further radicalized and the resolution of measurement improves.

[0101] As mentioned above, although the gestalt of each operation of this invention was explained, this invention is not limited to the gestalt of these operations.

[0102]

[Effect of the Invention] As explained above, when that the magnitude of a thermocouple and the precision of a location can be raised and the precision and resolution of measurement of the temperature distribution on the front face of a sample or thermal conductivity distribution can be raised, a probe, and a base material project in an opposite direction to a flexible plate, according to this invention, the cantilever and list which fulfill to coincidence the conditions of being able to raise resonance frequency and make rapid scanning possible can be provided with the manufacture approach.

[Translation done.]

* NOTICES *

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2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

TECHNICAL FIELD

[Field of the Invention] This invention relates to the suitable cantilever for a scan mold heat measurement microscope, and its manufacture approach especially about the cantilever used for a scan mold probe microscope, and its manufacture approach.

[Translation done.]

PRIOR ART

[Description of the Prior Art] In recent years, the scan mold probe microscope using the physicochemical interaction between a probe and a sample is studied actively. Especially the scan mold heat measurement microscope (STI: Scanning Thermal Iemager) that measures temperature distribution and thermal conductivity distribution on the front face of a sample is a microscope by which promising ** is carried out as the analysis technique of a semi-conductor of operation, or an analysis technique of the thermal property of an ingredient. It is imaging ******** to coincidence about the concavo-convex image of bending change of this cantilever by the interaction force produced between the probes and the sample front faces which protruded on the tip side field of this cantilever to a sample, and the temperature distribution of thermoelectromotive force to a sample or the heat-conductivity distribution which generated with the temperature measured with the thermocouple which is formed in the probe of this cantilever and consists of dissimilar metal junction using the cantilever which has the minute spring force formed with a thin film material under this microscope.
[0003] An example of the conventional cantilever used under this scan mold heat measurement microscope is shown in drawing 7 . The outline perspective view in which drawing 7 (a) shows this conventional cantilever, and drawing 7 (b) are the outline sectional views which met the A-A line in drawing 7 (a).
[0004] This conventional cantilever is equipped with the flexible plate 1 which consists of a silicon nitride film as an insulating material, the probe 2 which protruded on the inferior surface of tongue of the tip side field of this flexible plate 1, and the base material 3 joined to the inferior surface of tongue of the end face side field of the flexible plate 1. Therefore, the probe 2 and the base material 3 are projected in the same direction to the flexible plate 1. The probe 2 consists of metal membranes 13 and 14 of a mutually different class, and junction of the metal membranes 13 and 14 in the probe 2 concerned constitutes the thermocouple. The metal membrane 13 is caudad projected from opening formed in the part corresponding to a probe 2 in the flexible plate 1. The base material 3 consists of a silicon layer 10 and a silicon nitride film 12 formed in the inferior surface of tongue of this silicon layer 10. The electric conduction film 4 for wiring which consists of a metal membrane 13 which continued from the part of the thermocouple of a probe 2 is missing from said end face side field, and is formed in the top face of the flexible plate 1. Moreover, on the end face side field of the flexible plate 1, the electrode pattern 5 for electrical installation with the exterior which consists of a metal membrane 13 which followed the electric conduction film 4 for wiring (pad section) is formed. The metal membrane 14 is formed in the whole inferior surface of tongue of the metal membrane 13 projected from said opening of the flexible plate 1 and this flexible plate 1, and a base material 3.
[0005] The cantilever shown in drawing 7 is manufactured by the following approaches. Drawing 8 is the outline sectional view showing an example of the production process of the cantilever shown in drawing 7 .
[0006] First, the silicon substrate 10 of field (100) bearing is prepared, and the silicon nitride films 11 and 12 which serve as an ingredient of the flexible plate 1 to both sides of this substrate 10 are formed. Next, opening 11a of the shape of a square to which the front face of a substrate 10 is exposed is formed in the predetermined part of a silicon nitride film 11 by carrying out patterning of the silicon nitride film 11 on top using the lithography method and the dry etching method. Then, anisotropic etching of the part of the substrate 10 exposed from opening 11a is carried out by wet etching, and square drill-like trench 10a is formed in the bottom of opening 11a at a substrate 10 (drawing 8 (a)). Next, patterning of the metal membrane 13 is carried out to the field which is equivalent to wrap subregion, the field equivalent to said electric conduction film 4 for wiring, and said electrode pattern 5 in this trench 10a on the substrate of the condition which shows in drawing 8 (a) by the lift-off method (drawing 8 (b)).
[0007] Next, while carrying out patterning of the silicon nitride film 11 on top according to the configuration of the flexible plate 1 using the lithography method and the dry etching method, according to the configuration of a base material 3, patterning of the silicon nitride film 12 at the bottom is carried out (drawing 8 (c)). It is eluted and the silicon section of a substrate 10 which was immersed in the KOH water solution and finally exposed the substrate of the condition which shows in drawing 8 (c) is removed (drawing 8 (d)). The metal membrane 14 of an ingredient which is finally different from said metal membrane 13 on the whole inferior surface of tongue of the structure of the condition which shows in drawing 8 (d) is formed (drawing 8 (e)). Thereby, the cantilever shown in drawing 7 is completed. In addition, according to this manufacture approach, a silicon nitride film 11 constitutes the flexible plate 1, and the remaining substrate 10 and the remaining silicon nitride film 12 constitute a base material 3.
[0008] Moreover, other examples of the conventional cantilever used under the scan mold heat measurement microscope are shown in drawing 9 . The outline sectional view in which drawing 9 (a) shows this conventional cantilever, and drawing 9 (b) are the B-B view outline top views in drawing 9 (a).
[0009] This conventional cantilever is constituted using the cantilever for atomic force microscopes marketed. That is, the cantilever for atomic force microscopes concerned consists of the flexible plate 101 and probe 102 (the probe 102 protrudes on the inferior surface of tongue of the tip side field of the flexible plate 101.) which were constituted from a silicon nitride film by one, and a base material 103 which consists of a glass member joined to the top face of the end face side field of the flexible plate 1. And the metal membrane 104,105 of a class which is different as shown in drawing 9 (b) is partially formed in the field by the side of the probe 102 of the cantilever for atomic force microscopes concerned, the conventional cantilever shown in drawing 9 becomes [whether the part of a probe 102 is included, and], in the field of a large rhombus, a metal membrane 104,105 laps mutually, and is joined, and the lap part concerned constitutes the thermocouple. Therefore, the probe 106 of the cantilever shown in drawing 9 consists of a probe 102 which consists only of silicon nitride of said cantilever for atomic force microscopes, and a metal membrane 104,105 which lapped mutually [the part formed in the probe 102 inferior surface of tongue concerned].

[Translation done.]

* NOTICES *

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EFFECT OF THE INVENTION

[Effect of the Invention] As explained above, when that the magnitude of a thermocouple and the precision of a location can be raised and the precision and resolution of measurement of the temperature distribution on the front face of a sample or thermal conductivity distribution can be raised, a probe, and a base material project in an opposite direction to a flexible plate, according to this invention, the cantilever and list which fulfill to coincidence the conditions of being able to raise resonance frequency and make rapid scanning possible can be provided with the manufacture approach.

[Translation done.]

TECHNICAL PROBLEM

[Problem(s) to be Solved by the Invention] According to the conventional cantilever shown in the conventional cantilever and conventional drawing 9 which are shown in said drawing 7 , as mentioned above, since the thermocouple was formed in the probe, it was possible but to have acquired the concavo-convex image of a sample, the temperature distribution of a sample, or thermal conductivity distribution to coincidence, and as stated below, each conventional cantilever mentioned above had merits and demerits.
[0011] It will be decided by the cantilever shown in drawing 7 in the magnitude and the location of opening 11a of a silicon nitride film 11 which were formed on the substrate 10 which the magnitude and the location of a thermocouple mentioned above so that the explanation mentioned above may show. The opening 11a concerned can be formed using the lithography method (an aligner is used) and the dry etching method, as mentioned above. For this reason, while being able to form the magnitude and the location of said opening 11a with a very sufficient precision, it is possible to make area of opening 11a small. Therefore, area of a thermocouple can be made small while being able to form the magnitude and the location of a thermocouple with a very sufficient precision. Consequently, in the cantilever shown in drawing 7 , the precision and resolution of measurement of the temperature distribution on the front face of a sample or thermal conductivity distribution were high.
[0012] However, in the cantilever shown in drawing 7 , since the probe 2 and the base material 3 had projected in the same direction to the flexible plate 1, following un-arranging had arisen. Drawing 10 (a) is the outline sectional view showing typically signs that the front face of a sample 30 is measured by the cantilever shown in drawing 7 . Although it is necessary to make the probe 2 prepared in the tip side field of the flexible plate 1 at the time of measurement contact or approach the front face of a sample 30 as shown in drawing 10 (a) Since the probe 2 and the base material 3 have projected in the same direction to the flexible plate 1 by the cantilever shown in drawing 7 at this time In order for the corner ahead of a base material 3 to tend to hit a sample 30 and to avoid this, it had the fault that the part (namely, lever section) to which the base material 3 in the flexible plate 1 is not joined had to be lengthened comparatively. As everyone knows, under the scan mold probe microscope, in order to realize rapid scanning, it was desired for the resonance frequency of a cantilever to be high, but since the lever section had to be lengthened as mentioned above, the problem that a scan speed had to be made late about [conventional] with 1/50 had arisen.
[0013] On the other hand, in the cantilever shown in drawing 9 , since the probe 106 and the base material 103 have projected to the opposite direction to the flexible plate 101 As [hit / the corner of a base material 103 / as shown in drawing 10 (b) / at the time of measurement / a sample 30] The part (namely, lever section) to which the base material 24 in the flexible plate 101 is not joined can be shortened, resonance frequency of the cantilever concerned can be made high, and rapid scanning can be realized. Drawing 10 (b) is the outline sectional view showing typically signs that the front face of a sample 30 is measured by the cantilever shown in drawing 9 .
[0014] However, in the cantilever shown in drawing 9 , although a metal membrane 104,105 is formed in the field by the side of the probe of the cantilever for atomic force microscopes, mask vacuum evaporationo etc. cannot but perform formation of a metal membrane 104,105. For this reason, while being unable to form the magnitude and the location of a lap part (namely, thermocouple) of a metal membrane 104,105 with so sufficient a precision, the area of the thermocouple concerned cannot but become large. For this reason, in the cantilever shown in drawing 9 , the precision and resolution of measurement of the temperature distribution on the front face of a sample or thermal conductivity distribution were falling.
[0015] This invention was made in view of such a situation, can raise the magnitude of a thermocouple, and the precision of a location, and the precision and resolution of measurement of the temperature distribution on the front face of a sample or thermal conductivity distribution can be raised, And when a probe and a base material project in an opposite direction to a flexible plate, it aims at providing with the manufacture approach the cantilever which can fulfill to coincidence the conditions of being able to raise resonance frequency and making rapid scanning possible, and a list.

[Translation done.]

MEANS

[Means for Solving the Problem] In order to solve said technical problem, the cantilever by the 1st mode of this invention The flexible plate which consists of an insulating material, and the probe which protruded on the field of one side of the tip side field of this flexible plate, The base material joined by the field of the other side of the end face side field of said flexible plate, The thermocouple which becomes a preparation and said probe from junction to the 1st metallic material and the 2nd metallic material is formed. Said 1st metallic material is continuously formed in the field by the side of said base material of said flexible plate from the part of said thermocouple. In the field by the side of said base material of said flexible plate While connecting with said 1st metallic material electrically, the 1st electric conduction film for wiring which extends to said end face side field is formed.

[0017] Said 1st metallic material may be prolonged as it is, what may consist of different ingredients and added two or more film one by one is sufficient as said 1st metallic material, and the film which consists of two or more layers is sufficient as said 1st electric conduction film for wiring.

[0018] Since the 1st metallic material which constitutes a thermocouple is continuously formed in the field by the side of said base material of said flexible plate (namely, field of a probe and the opposite side) from the part of a thermocouple according to this 1st mode, before removing the substrate which is in the middle of manufacture, is used at the time of manufacture, and is removed at the end at it, the 1st metallic material can be formed. Therefore, on the occasion of film formation of the 1st metallic material, the accurate film formation technique using aligners, such as the lift-off method, is employable. For this reason, according to said 1st mode, while being able to form the magnitude and the location of a thermocouple with a very sufficient precision, area of a thermocouple can be made small, as a result the precision and resolution of measurement of the temperature distribution on the front face of a sample or thermal conductivity distribution can be raised.

[0019] Moreover, in the cantilever by said 1st mode, a probe protrudes on the field of one side of a flexible plate, the base material is joined by the field of the other side of a flexible plate, and the probe and the base material have projected to the opposite direction to the flexible plate. Therefore, the part (namely, lever section) to which the base material in a flexible play is not joined can be shortened so that the corner of a base material cannot hit a sample at the time of measurement, resonance frequency of the cantilever concerned can be made high, and rapid scanning can be realized.

[0020] In the cantilever according [the cantilever by the 2nd mode of this invention] to said 1st mode So that said base material may consist of an electrical conducting material and said the 1st electric conduction film for wiring and said base material may be connected electrically Said flexible plate and said base material are joined, and said 2nd metallic material is continuously formed in the field by the side of said probe of said flexible plate from the part of said thermocouple. While connecting with said 2nd metallic material electrically, the 2nd electric conduction film for wiring which extends to said end face side field is formed in the field by the side of said probe of said flexible plate.

[0021] Said 2nd metallic material may be prolonged as it is, what may consist of different ingredients and added two or more film one by one is sufficient as said 2nd metallic material, and the film which consists of two or more layers is sufficient as said 2nd electric conduction film for wiring.

[0022] This 2nd mode is the example of said 1st mode, and is an example using what forms the 2nd metallic material in the 1st metallic material and opposite side to a flexible plate, and consists of an electrical conducting material as a base material further. A 1st [of a thermocouple] metallic material side can be connected outside through the 1st electric conduction film for wiring and base material itself, and a 2nd [of a thermocouple] metallic material side can be connected outside through the 2nd electric conduction film for wiring. in addition, the 2nd metallic material from being formed in the probe side of a flexible plate By joining the 1st metallic material and 2nd metallic material through opening formed in the flexible plate, although membranes are formed by mask vacuum evaporationo etc. and the magnitude and the location of itself cannot be formed with so sufficient a precision Like the conventional cantilever shown in drawing 7 mentioned above, while being able to form the magnitude and the location of a thermocouple of a thermocouple with a very sufficient precision, area of a thermocouple can be made small.

[0023] Said base material consists of an insulating material in the cantilever according [the cantilever by the 3rd mode of this invention] to said 1st mode. Between said flexible plates and said base materials It intervenes so that a part of 1st conductor for external connection may be electrically connected with said 1st electric conduction film for wiring. Said a part of other 1st conductor for external connection is drawn outside, and said 2nd metallic material is continuously formed in the field by the side of said probe of said flexible plate from the part of said thermocouple. The 2nd electric conduction film for wiring which extends to said end face side field is formed in the field by the side of said probe of said flexible plate.

[0024] Said 2nd metallic material may be prolonged as it is, what may consist of different ingredients and added two or more film one by one is sufficient as said 2nd metallic material, and the film which consists of two or more layers is sufficient as said 2nd electric conduction film for wiring.

[0025] This 3rd mode is the example of said 1st mode, and is an example using what forms the 2nd metallic material in the 1st metallic material and opposite side to a flexible plate, and consists of an insulating material as a base material further. A 1st [of a thermocouple] metallic material side can be connected outside through the 1st electric conduction film for wiring, and the 1st conductor for external connection, and a 2nd [of a thermocouple] metallic material side can be connected outside through the 2nd electric conduction film for wiring. in addition, the 2nd metallic material from being formed in the probe side of a flexible plate By joining

the 1st metallic material and 2nd metallic material through opening formed in the flexible plate, although membranes are formed by mask vacuum evaporationo etc. and the magnitude and the location of itself cannot be formed with so sufficient a precision Like the conventional cantilever shown in drawing 7 mentioned above, while being able to form the magnitude and the location of a thermocouple of a thermocouple with a very sufficient precision, area of a thermocouple can be made small.

[0026] the 4th voice of this invention -- the cantilever depended like -- said 3rd voice -- in the cantilever depended like, said 1st conductor for external connection is the electric conduction film for wiring formed in the field which does not lap with said flexible plate from the field which laps with said flexible plate in the field by the side of said flexible plate of said base material, having covered.

[0027] Although the 1st conductor for external connection may be conductors, such as a metallic foil and a metal wire, in said 3rd mode like said 4th mode If the electric conduction film for wiring formed in the field of a base material is used as 1st conductor for external connection For example, the cantilever concerned can be mass-produced using the batch process using a semi-conductor manufacturing technology like the manufacture approach by the 8th mode mentioned later, and the cantilever concerned can be offered cheaply.

[0028] Said base material consists of an insulating material in the cantilever according [the cantilever by the 5th mode of this invention] to said 1st mode. Between said flexible plates and said base materials It intervenes so that a part of 1st conductor for external connection may be electrically connected with said 1st electric conduction film for wiring. Said a part of other 1st conductor for external connection is drawn outside, and said 2nd metallic material is continuously formed in the field by the side of said base material of said flexible plate from the part of said thermocouple. In the field by the side of said base material of said flexible plate The 2nd electric conduction film for wiring which extends to said end face side field while connecting with said 2nd metallic material electrically is formed. Between said flexible plates and said base materials It intervenes so that a part of 2nd conductor for external connection may be electrically connected with said 2nd electric conduction film for wiring, and said a part of other 2nd conductor for external connection is drawn outside.

[0029] Said 2nd metallic material may be prolonged as it is, what may consist of different ingredients and added two or more film one by one is sufficient as said 2nd metallic material, and the film which consists of two or more layers is sufficient as said 2nd electric conduction film for wiring.

[0030] This 5th mode is the example of said 1st mode, and is an example using what forms the 2nd metallic material in a base material side as well as the 1st metallic material to a flexible plate, and consists of an insulating material as a base material further. A 1st [of a thermocouple] metallic material side can be connected outside through the 1st electric conduction film for wiring, and the 1st conductor for external connection, and a 2nd [of a thermocouple] metallic material side can be connected outside through the 2nd electric conduction film for wiring, and the 2nd conductor for external connection. In addition, since not only the 1st metallic material but the 2nd metallic material is formed in the base material side of a flexible plate, before removing the substrate which is in the middle of manufacture, is used at the time of manufacture, and is removed at the end at it, it can be formed. Therefore, area of a thermocouple can be made small, while being able to adopt the accurate film formation technique in which aligners, such as the lift-off method, were used, not only in the 1st metallic material but in the case of film formation of the 2nd metallic material and being able to form the magnitude and the location of a both lap part, i.e., a thermocouple, with a very sufficient precision at it.

[0031] the 6th voice of this invention -- the cantilever depended like -- said 5th voice -- in the cantilever depended like, each of said 1st and 2nd conductors for external connection is the electric conduction film for wiring formed in the field which does not lap with said flexible plate from the field which laps with said flexible plate in the field by the side of said flexible plate of said base material, having covered.

[0032] Although the 1st and 2nd conductors for external connection may be conductors, such as a metallic foil and a metal wire, in said 5th mode like said 6th mode If the electric conduction film for wiring formed in the field of a base material is used as 1st and 2nd conductors for external connection For example, the cantilever concerned can be mass-produced using the batch process using a semi-conductor manufacturing technology like the manufacture approach by the 10th mode mentioned later, and the cantilever concerned can be offered cheaply.

[0033] the 7th voice of this invention -- the cantilever depended like -- said 1st [the], the 3rd, or the 6th one of voice -- in the cantilever depended like, said base material consists of a glass member containing movable ion, and said flexible plate and said base material are joined by anode plate junction.

[0034] Like this 7th mode, when anode plate junction is adopted, junction between a flexible plate and a base material becomes easy, and it is desirable.

[0035] The cantilever by the 8th mode of this invention is the approach of manufacturing the cantilever by said 4th mode. (1) It is the structure which has a substrate, the thin film formed in this substrate front face, and the 1st metal membrane. While patterning of said thin film is carried out according to the configuration of said flexible plate, it has opening in the location corresponding to said probe. It has a crevice for said substrate to imprint the configuration of said probe under said opening of said thin film. The process by which extended on said thin film from this field, and patterning was carried out according to the configuration of said 1st electric conduction film for wiring while said 1st metal membrane was formed in the wrap field in said crevice and which prepares the structure, (2) The process which prepares the insulating member by which the 2nd metal membrane by which patterning was carried out according to the configuration of said 1st conductor for external wiring was formed in the inferior surface of tongue, (3) Alignment of said structure and said insulating member is carried out so that said a part of 1st metal membrane and said a part of 2nd metal membrane may lap and contact. the process which joins the inferior surface of tongue of said insulating member to the top face of said thin film, and (4) -- the process which removes said substrate, and (5) -- it has the process which forms the 3rd metal membrane in the near predetermined field to which said substrate in the structure which remained after removal of said substrate existed.

[0036] The manufacture approach of the cantilever by the 9th mode of this invention In the manufacture approach by said 8th mode, said process which prepares said structure The process which forms a thin film in said substrate front face, and the process which forms said opening in this thin film, The process which etches the part of said substrate exposed from the opening concerned, and forms the trench as said crevice in the bottom of the opening concerned in said substrate, While said crevice is located in the wrap aforementioned field, it has the process which forms said 1st metal membrane by which patterning was carried out according to the configuration of said 1st electric conduction film for wiring so that it might extend on said thin film from the field concerned.

[0037] The manufacture approach of the cantilever by the 10th mode of this invention It is the approach of manufacturing the cantilever by said 6th mode, and is the structure which has (1) substrate, the thin film formed in this substrate front face, and the 1st

and 2nd metal membranes. While patterning of said thin film is carried out according to the configuration of said flexible plate, it has opening in the location corresponding to said probe. It has a crevice for said substrate to imprint the configuration of said probe under said opening of said thin film. While said 1st metal membrane is formed in a wrap field in said crevice, extend on said thin film from this field, and patterning is carried out according to the configuration of said 1st electric conduction film for wiring. The process by which extended on said thin film from the lap field concerned, and patterning was carried out according to the configuration of said 2nd electric conduction film for wiring while being formed so that said 2nd metal membrane might lap with said 1st metal membrane in said crevice and which prepares the structure, (2) The process which prepares the insulating member by which the 3rd and 4th metal membranes by which patterning was carried out respectively according to the configuration of said 1st and 2nd conductors for external wiring were formed in the inferior surface of tongue, (3) Alignment of said structure and said insulating member is carried out so that said a part of 2nd metal membrane and said a part of 4th metal membrane may lap and contact, while said a part of 1st metal membrane and said a part of 3rd metal membrane lap and contact. the process which joins the inferior surface of tongue of said insulating member to the top face of said thin film, and (4) -- it has the process which removes said substrate.

[0038] The manufacture approach of the cantilever by the 11th mode of this invention In the manufacture approach by said 10th mode, said process which prepares said structure The process which forms a thin film in said substrate front face, and the process which forms said opening in this thin film, The process which etches the part of said substrate exposed from the opening concerned, and forms the trench as said crevice in the bottom of the opening concerned in said substrate, The process which forms said 1st metal membrane by which patterning was carried out according to the configuration of said 1st electric conduction film for wiring so that it might extend on said thin film from the field concerned while said crevice is located in the wrap aforementioned field, The process which forms said 1st metal membrane by which patterning was carried out according to the configuration of said 1st electric conduction film for wiring so that it might extend on said thin film from the field concerned while said crevice is located in the wrap aforementioned field, While being located so that it may lap with said 1st metal membrane in said crevice, it has the process which forms said 2nd metal membrane by which patterning was carried out according to the configuration of said 2nd electric conduction film for wiring so that it might extend on said thin film from the lap field concerned.

[0039] the 12th voice of this invention -- the manufacture approach of the cantilever depended like -- said 9th or 11th voice -- in the manufacture approach depended like, said process which prepares said structure has the process which makes the wall of said trench of said substrate make it steep by thermal oxidation before said process which is after said process which forms said trench, and forms said 1st metal membrane.

[0040] the 13th voice of this invention -- the manufacture approach of the cantilever depended like -- said voice of either the 8th thru/or the 12th either -- in the manufacture approach depended like, said insulating member consists of a glass member containing movable ion, and said process to join is a process which carries out anode plate junction of the inferior surface of tongue of said insulating member on the top face of said thin film.

[0041] The manufacture approach by said the 8th thru/or 13th mode is an example of the manufacture approach of the cantilever by said 4th or 6th mode, respectively. A cantilever can be manufactured according to the batch process using a semi-conductor manufacturing technology, and any manufacture approach can be mass-produced and can manufacture a cantilever cheaply. It is desirable, when it has the process which makes the wall of said trench of a substrate make it steep by thermal oxidation like said 12th mode, and it can be further radicalized in the point of a probe and the resolution of measurement is raised. Like said 13th mode, when anode plate junction is used for junction between an insulating member and a thin film, the junction becomes easy and it is desirable.

[0042]

[Embodiment of the Invention] Hereafter, the cantilever by this invention and its manufacture approach are explained to a detail with reference to a drawing.

[0043] First, the cantilever by the gestalt of operation of the 1st of this invention is explained with reference to drawing 1 . The cantilever by the gestalt of this operation is constituted as a cantilever for microscopes which attains both the functions of a scan mold heat measurement microscope and a scan mold atomic force microscope.

[0044] The outline perspective view showing the cantilever according [drawing 1 (a)] to the gestalt of this operation and drawing 1 (b) are the outline sectional views which met the C-C line in drawing 1 (a). In addition, although the upper and lower sides are conversely shown by drawing 1 (a) and drawing 1 (b), in the following explanation, the upper and lower sides shall follow drawing 1 (b).

[0045] The cantilever by the gestalt of this operation is equipped with the flexible plate 41 which consists of an insulating material, the probe 42 which protruded on the inferior surface of tongue of the tip side field of this flexible plate 41, and the base material 43 which consists of an insulating material joined to the top face of the end face side field of the flexible plate 41 as shown in drawing 1 . Therefore, the probe 42 and the base material 3 are projected to the opposite direction to the flexible plate 41.

[0046] The probe 42 consists of metal membranes (metallic material) 44 and 45 of a different class, and junction of the metal membranes 44 and 45 in the probe 42 concerned constitutes the thermocouple from a gestalt of this operation. But by this invention, the whole probe 42 does not need to consist of metal membranes 44 and 45, and you may consist of metal membranes of the class from which a part of probe 42 differs. In addition, the metal membrane 44 is caudad projected from opening formed in the part corresponding to a probe 42 in the flexible plate 41.

[0047] Said metal membrane 44 is continuously formed in the top face (field by the side of a base material 43) of the flexible plate 41 from the part of a thermocouple. Moreover, while connecting with a metal membrane 44 electrically, the electric conduction film 46 for wiring which extends to the end face side field of the flexible plate 41 is formed in the top face of the flexible plate 41. The electric conduction film 46 for wiring consists of gestalten of this operation as that to which the metal membrane 44 extended as it is. But what may consist of different metallic materials from a metal membrane 44, and added two or more film is sufficient as the electric conduction film 46 for wiring, and it may be film which consists of two or more layers.

[0048] Said metal membrane 45 is continuously formed in the inferior surface of tongue (near field of a probe 42) of the flexible plate 41 from the part of said thermocouple. Moreover, while connecting with a metal membrane 45 electrically, the electric conduction film 47 for wiring which extends to the end face side field of the flexible plate 41 is formed in the inferior surface of tongue of the flexible plate 41. The electric conduction film 47 for wiring consists of gestalten of this operation as that to which the metal membrane 45 extended as it is. But what may consist of different metallic materials from a metal membrane 45, and added two or more film is sufficient as the electric conduction film 47 for wiring, and it may be film which consists of two or more layers.

[0049] The electric conduction film 48 for wiring which consists of a metal membrane which is missing from the field which does not lap

with the flexible plate 41, and extends is formed in the inferior surface of tongue (field by the side of the flexible plate 41) of a base material 43 from the field which laps with the flexible plate 41. The part of the edge in said field of the electric conduction film 48 for wiring with which it does not lap is electrode pad section 48a for electrical installation with the exterior. While this electric conduction film 48 for wiring intervenes so that a part may be electrically connected with the electric conduction film 46 for wiring, other parts constitute the conductor for external connection drawn outside from a gestalt of this operation. But in this invention, conductors, such as a metallic foil and a metal wire, may be used as the conductor for external connection concerned.

[0050] And the flexible plate 41 and the base material 43 are joined so that the electric conduction film 46 for wiring and the electric conduction film 48 for wiring may contact and it may connect electrically. With the gestalt of this operation, a base material 43 consists of a glass ingredient (for example, boro-silicated glass) containing movable ion, and the flexible plate 41 and the base material 43 are joined by anode plate junction. But in this invention, a base material 43 may be constituted from other insulating materials, and the junction between the flexible plate 41 and a base material 43 is not necessarily limited to anode plate junction. In addition, specifically as a glass ingredient which was mentioned above, Pyrex glass (trade name) can be mentioned. In addition, although what consists of an insulating material as a base material 43 in this way is used with the gestalt of this operation, what consists of electrical conducting materials, such as a metal, as a base material 43 may be used in this invention. In this case, the electric conduction film 48 for wiring is removed, and the flexible plate 41 and the electric conduction film 46 for wiring are joined so that a base material 43 and the electric conduction film 46 for wiring may be connected electrically.

[0051] Next, an example of the manufacture approach of the cantilever shown in drawing 1 is explained with reference to drawing 2 . Drawing 2 is the outline sectional view showing an example of the production process of the cantilever shown in drawing 1 .

[0052] first -- as a substrate ingredient (100) -- the silicon substrate 50 with a diameter [of field bearing / of 3 inches], and a thickness of 250 micrometers -- using -- LPCVD -- the silicon nitride films 51 and 52 with a thickness of 700nm are formed to both sides of a substrate 50 by law (reduced pressure CVD method) etc. (a silicon nitride film 51 is equivalent to the flexible plate 41 in drawing 1). Next, opening 51a of the shape of a square to which the front face of a substrate 50 is exposed is formed in the predetermined part of a silicon nitride film 51 by carrying out patterning of the silicon nitride film 51 on top using the lithography method and the dry etching method. In this example, two or more cantilevers are manufactured to coincidence, and only the number corresponding to the number of the cantilevers which opening 51a tends to manufacture to coincidence is formed. In addition, the pattern configuration of opening 51a, magnitude, and quantity can be set as arbitration. Next, this substrate is immersed in the etching reagent for silicon, such as a potassium-hydroxide (KOH) water solution or a tetramethylammonium hydroxide (TMAH) water solution, silicon nitride films 51 and 52 are used as a mask, anisotropic etching of the part of the substrate 50 exposed from opening 51a is carried out, and trench 50a is formed in the bottom of opening 51a (drawing 2 (a)). Trench 50a is constituted by the silicon (111) side, and becomes a square drill-like crevice. In this example, it becomes a crevice for trench 50a to imprint the configuration of said probe 42.

[0053] Next, while carrying out patterning of the silicon nitride film 51 on top according to the configuration of the flexible plate 41 using the lithography method and the dry etching method, the silicon nitride film 52 at the bottom is removed (drawing 2 (b)).

[0054] Then, patterning of the metal membrane 53 (equivalent to the metal membrane 44 in drawing 1) is carried out to the field which is equivalent to a wrap field and the electric conduction film 46 for wiring in trench 50a on the substrate of the condition which shows in drawing 2 (b) by the lift-off method (drawing 2 (c)). Nichrome (NiCr) can be used as a metal membrane 53.

[0055] In addition, the process which removes a silicon nitride film 52 while carrying out patterning of the silicon nitride film 51 explained with reference to drawing 2 (b), and the process which forms the metal membrane 53 explained with reference to drawing 2 (c) may be performed by the reverse order.

[0056] Although the above process constitutes the process which prepares the structure shown in drawing 2 (c), the process which prepares the structure shown in drawing 2 (c) is not necessarily limited to what is depended on such each process.

[0057] The Pyrex glass member 55 (equivalent to the base material 43 in drawing 1) by which the metal membranes 54 (equivalent to the electric conduction film 48 for wiring), such as gold by which patterning was carried out according to the configuration of said electric conduction film 48 for wiring, were formed in the inferior surface of tongue on the other hand is prepared (drawing 2 (d)). With the gestalt of this operation, slot 55a for avoiding that a tabular thing is used as a Pyrex glass member 55, and a garbage is joined by the anode plate junction mentioned later is beforehand formed in the inferior surface of tongue of processing by the dicing saw. If it puts in another way, a bridge is constructed over between the parts which should serve as said two or more base materials 43 for a cantilever by the part in which slot 55a is formed, and the Pyrex glass member 55 is making tabular as a whole. In addition, the slot for separation (not shown) is formed in the part in which slot 55a is formed.

[0058] Next, alignment of said structure and said Pyrex glass member 55 is carried out so that a part of metal membrane 53 of the structure shown in drawing 2 (c) and a part of metal membrane 54 of the inferior surface of tongue of said Pyrex glass member 55 may lap and contact, and anode plate junction of the inferior surface of tongue of the Pyrex glass member 55 is carried out on the top face of the silicon nitride film 51 of said structure (drawing 2 (d)). At this time, a part of metal membrane 53 and a part of metal membrane 54 will be stuck by pressure, and it will connect electrically.

[0059] Subsequently, the part in which said slot 55 in the Pyrex glass member 55 is formed is excised by processing by the dicing saw. However, said excision is not performed about the edges of the train in which said slot for separation is formed, and each train. Next, the structure of this condition is immersed in a KOH water solution or a TMAH water solution, and a substrate 50 is removed. Since there is nothing a limping gait crack completely as said excision mentioned above, each cantilever is connected also in this condition (that connection condition is not shown in drawing 2 .). Subsequently, the metal membranes 58 (equivalent to the metal membrane 45 in drawing 1), such as Ti with a thickness of about 50nm, are partially formed by vacuum evaporationo etc. by using a metal sheet with opening as a masking object to the probe side of the structure of this condition (drawing 2 (e)). Finally, it separates into each cantilever using said slot for separation. Thereby, the cantilever shown in drawing 1 is completed. But a cantilever [being connected] is supplied to a measurement person and a measurement person may be made to separate into each cantilever using said slot for separation.

[0060] It will be decided by the cantilever shown in drawing 1 in the magnitude and the location of opening 51a of a silicon nitride film 51 which were formed on the substrate 50 which the magnitude and the location of a thermocouple mentioned above so that the explanation mentioned above may show. The opening 51a concerned can be formed using the lithography method (an aligner is used) and the dry etching method, as mentioned above. For this reason, while being able to form the magnitude and the location of said

opening 51a with a very sufficient precision, it is possible to make area of opening 51a small. Therefore, area of a thermocouple can be made small while being able to form the magnitude and the location of a thermocouple with a very sufficient precision. Consequently, in the cantilever shown in drawing 1 , the precision and resolution of measurement of the temperature distribution on the front face of a sample or thermal conductivity distribution become high.

[0061] Moreover, in the cantilever shown in drawing 1 , the probe 42 and the base material 43 have projected to the opposite direction to the flexible plate 41. Therefore, like the case of drawing 10 (b), the part (namely, lever section) to which the base material 43 in the flexible play 41 is not joined can be shortened, resonance frequency of the cantilever concerned can be made high, and rapid scanning can be realized so that the corner of a base material 43 may not hit a sample at the time of measurement.

[0062] Furthermore, in the cantilever shown in drawing 1 , the cantilever concerned can be mass-produced using the batch process using a semi-conductor manufacturing technology which was explained with reference to drawing 2 , and the cantilever concerned can be offered cheaply.

[0063] Next, other examples of the manufacture approach of the cantilever shown in drawing 1 are explained with reference to drawing 3 . Drawing 3 is the outline sectional view showing other examples of the production process of the cantilever shown in drawing 1 . In drawing 3 , the same sign is given to the same as that of the element in drawing 2 , or a corresponding element.

[0064] first -- as a substrate ingredient (100) -- the silicon substrate 50 with a diameter [of field bearing / of 3 inches], and a thickness of 250 micrometers -- using -- LPCVD -- the silicon nitride films 51 and 52 with a thickness of 700nm are formed to both sides of a substrate 50 by law (reduced pressure CVD method) etc. (a silicon nitride film 51 is equivalent to the flexible plate 41 in drawing 1). Next, opening 51a of the shape of a square to which the front face of a substrate 50 is exposed is formed in the predetermined part of a silicon nitride film 51 by carrying out patterning of the silicon nitride film 51 on top using the lithography method and the dry etching method. Also in this example, two or more cantilevers are manufactured to coincidence, and only the number corresponding to the number of the cantilevers which opening 51a tends to manufacture to coincidence is formed. In addition, the pattern configuration of opening 51a, magnitude, and quantity can be set as arbitration. Next, this substrate is immersed in the etching reagent for silicon, such as a potassium-hydroxide (KOH) water solution or a tetramethylammonium hydroxide (TMAH) water solution, silicon nitride films 51 and 52 are used as a mask, anisotropic etching of the part of the substrate 50 exposed from opening 51a is carried out, and trench 50a is formed in the bottom of opening 51a (drawing 3 (a)). Trench 50a is constituted by the silicon (111) side, and becomes a square drill-like crevice. In this example, trench 50a is constituted by the silicon (111) side, and becomes a square drill-like crevice.

[0065] Subsequently, heat the substrate of the condition which shows in drawing 3 (a) in an oxygen ambient atmosphere, the wall of trench 50a of the exposed substrate 50 is made to oxidize thermally (thermal oxidation of which format, such as wet oxidation and dry oxidation, is sufficient), and the oxidation silicon film 56 is formed (drawing 3 (b)). Since oxidization progresses late in the corner section of a silicon crystal, it becomes steep especially near the pars basilaris ossis occipitalis of trench 50a (i.e., the point of a square drill). In this example, it becomes a crevice for this trench 50a made steep to imprint the configuration of a probe 42.

[0066] Next, while carrying out patterning of the silicon nitride film 51 on top according to the configuration of the flexible plate 41 using the lithography method and the dry etching method, the silicon nitride film 52 at the bottom is removed (drawing 3 (c)).

[0067] Then, patterning of the metal thin film 53 (equivalent to the metal membrane 44 in drawing 1) is carried out to the field which is equivalent to a wrap field and the electric conduction film 46 for wiring in trench 50a on the substrate of the condition which shows in drawing 3 (c) made steep by the lift-off method (drawing 3 (d)).

[0068] Although the above process constitutes the process which prepares the structure shown in drawing 3 (d), the process which prepares the structure shown in drawing 3 (d) is not necessarily limited to what is depended on such each process.

[0069] The Pyrex glass member 55 (equivalent to the base material 43 in drawing 1) by which the metal membranes 54 (equivalent to the electric conduction film 48 for wiring), such as gold by which patterning was carried out according to the configuration of said electric conduction film 48 for wiring, were formed in the inferior surface of tongue on the other hand is prepared (drawing 3 (e)). With the gestalt of this operation, slot 55a for avoiding that a tabular thing is used as a Pyrex glass member 55, and a garbage is joined by the anode plate junction mentioned later is beforehand formed in the inferior surface of tongue of processing by the dicing saw. If it puts in another way, a bridge is constructed over between the parts which should serve as said two or more base materials 43 for a cantilever by the part in which slot 55a is formed, and the Pyrex glass member 55 is making tabular as a whole. In addition, the slot for separation (not shown) is formed in the part in which slot 55a is formed.

[0070] Next, alignment of said structure and said Pyrex glass member 55 is carried out so that a part of metal membrane 53 of the structure shown in drawing 3 (d) and a part of metal membrane 54 of the inferior surface of tongue of said Pyrex glass member 55 may lap and contact, and anode plate junction of the inferior surface of tongue of the Pyrex glass member 55 is carried out on the top face of the silicon nitride film 51 of said structure (drawing 3 (e)). At this time, a part of metal membrane 53 and a part of metal membrane 54 will be stuck by pressure, and it will connect electrically.

[0071] Subsequently, the part in which said slot 55 in the Pyrex glass member 55 is formed is excised by processing by the dicing saw. However, said excision is not performed about the edges of the train in which said slot for separation is formed, and each train. Then, the structure of this condition is immersed in a KOH water solution or a TMAH water solution, and a substrate 50 and the oxidation silicon film 56 are removed. Since there is nothing a limping gait crack completely as said excision mentioned above, each cantilever is connected also in this condition (that connection condition is not shown in drawing 2 .). Next, the metal membranes 58 (equivalent to the metal membrane 45 in drawing 1), such as Ti with a thickness of about 50nm, are partially formed by vacuum evaporationo etc. by using a metal sheet with opening as a masking object to the probe side of the structure of this condition (drawing 3 (f)). Finally, it separates into each cantilever using said slot for separation. Thereby, the cantilever shown in drawing 1 is completed. But a cantilever [being connected] is supplied to a measurement person and a measurement person may be made to separate into each cantilever using said slot for separation.

[0072] In the cantilever obtained by the manufacture approach explained with reference to drawing 3 , since the crevice for imprinting the configuration of a probe 2 is set to trench 50a made steep, compared with the cantilever manufactured by the manufacture approach explained with reference to drawing 2 , the point of a probe 43 is further radicalized and the resolution of measurement improves.

[0073] Next, the cantilever by the gestalt of operation of the 2nd of this invention is explained with reference to drawing 4 . The cantilever by the gestalt of this operation is also constituted as a cantilever for microscopes which attains both the functions of a scan

mold heat measurement microscope and a scan mold atomic force microscope.
[0074] The outline perspective view showing the cantilever according [drawing 4 (a)] to the gestalt of this operation and drawing 4 (b) are the outline sectional views in alignment with D-D line in drawing 4 (a). In addition, although the upper and lower sides are conversely shown by drawing 4 (a) and drawing 4 (b), in the following explanation, the upper and lower sides shall follow drawing 4 (b). In drawing 4 , the same sign is given to the same as that of the element in drawing 1 , or a corresponding element, and the duplicate explanation is omitted.
[0075] The places where the cantilever by the gestalt of this operation differs from the cantilever shown in drawing 1 are the following points.
[0076] With the gestalt of this operation, the metal membrane 45 (therefore, also electric conduction film 47 for wiring) in drawing 1 is removed, and the metal membrane 145 of a class which is different in a metal membrane 44, the electric conduction film 147 for wiring, and the electric conduction film 148 for wiring are added instead.
[0077] That is, the probe 42 consists of said metal membrane 44 and a metal membrane 145 formed on this metal membrane 44, and junction of the metal membrane 44,145 in the probe 42 concerned constitutes the thermocouple. The metal membrane 145 has lapped with the metal membrane 44 only in the part of a probe 42. The metal membrane 145 is continuously formed in the top face (field by the side of a base material 43) of the flexible plate 41 from the part of a thermocouple. Moreover, while connecting with a metal membrane 145 electrically, said electric conduction film 147 for wiring which extends to the end face side field of the flexible plate 41 is formed in the top face of the flexible plate 41. The electric conduction film 147 for wiring consists of gestalten of this operation as that to which the metal membrane 145 extended as it is. But what may consist of different metallic materials from a metal membrane 145, and added two or more film is sufficient as the electric conduction film 147 for wiring, and it may be film which consists of two or more layers.
[0078] The electric conduction film 148 for wiring which consists of a metal membrane which is missing from the field which does not lap with the flexible plate 41, and extends is formed in the inferior surface of tongue (field by the side of the flexible plate 41) of a base material 43 from the field which laps with the flexible plate 41. The part of the edge in said field of the electric conduction film 148 for wiring with which it does not lap is electrode pad section 148a for electrical installation with the exterior. While this electric conduction film 148 for wiring intervenes so that a part may be electrically connected with the electric conduction film 147 for wiring, other parts constitute the conductor for external connection drawn outside from a gestalt of this operation. But in this invention, conductors, such as a metallic foil and a metal wire, may be used as the conductor for external connection concerned.
[0079] And the flexible plate 41 and the base material 43 are joined so that the electric conduction film 147 for wiring and the electric conduction film 148 for wiring may contact and it may connect electrically. With the gestalt of this operation, a base material 43 consists of a glass ingredient (for example, boro-silicated glass) containing movable ion, and the flexible plate 41 and the base material 43 are joined by anode plate junction. But in this invention, a base material 43 may be constituted from other insulating materials, and the junction between the flexible plate 41 and a base material 43 is not necessarily limited to anode plate junction.
[0080] Next, an example of the manufacture approach of the cantilever shown in drawing 4 is explained with reference to drawing 5 . Drawing 5 is the outline sectional view showing an example of the production process of the cantilever shown in drawing 4 . In drawing 5 , the same sign is given to the same as that of the element in drawing 2 , or a corresponding element.
[0081] first -- as a substrate ingredient (100) -- the silicon substrate 50 with a diameter [of field bearing / of 3 inches], and a thickness of 250 micrometers -- using -- LPCVD -- the silicon nitride films 51 and 52 with a thickness of 700nm are formed to both sides of a substrate 50 by law (reduced pressure CVD method) etc. (a silicon nitride film 51 is equivalent to the flexible plate 41 in drawing 4). Next, opening 51a of the shape of a square to which the front face of a substrate 50 is exposed is formed in the predetermined part of a silicon nitride film 51 by carrying out patterning of the silicon nitride film 51 on top using the lithography method and the dry etching method. In this example, two or more cantilevers are manufactured to coincidence, and only the number corresponding to the number of the cantilevers which opening 51a tends to manufacture to coincidence is formed. In addition, the pattern configuration of opening 51a, magnitude, and quantity can be set as arbitration. Next, this substrate is immersed in the etching reagent for silicon, such as a potassium-hydroxide (KOH) water solution or a tetramethylammonium hydroxide (TMAH) water solution, silicon nitride films 51 and 52 are used as a mask, anisotropic etching of the part of the substrate 50 exposed from opening 51a is carried out, and trench 50a is formed in the bottom of opening 51a (drawing 5 (a)). Trench 50a is constituted by the silicon (111) side, and becomes a square drill-like crevice. In this example, it becomes a crevice for trench 50a to imprint the configuration of said probe 42.
[0082] Next, while carrying out patterning of the silicon nitride film 51 on top according to the configuration of the flexible plate 41 using the lithography method and the dry etching method, the silicon nitride film 52 at the bottom is removed (drawing 5 (b)).
[0083] Then, patterning of the metal membranes 53 (equivalent to the metal membrane 44 in drawing 4), such as Nichrome (NiCr), is carried out to the field which is equivalent to a wrap field and the electric conduction film 46 for wiring in trench 50a on the substrate of the condition which shows in drawing 5 (b) by the lift-off method. Subsequently, patterning of the metal membranes 245 (equivalent to the metal membrane 145 in drawing 4), such as Ti, is carried out to the field equivalent to said electric conduction film 147 for wiring which extends on a silicon nitride film 51 from the field which laps with a metal membrane 53 in trench 50a on the substrate of this condition, and the lap field concerned by the lift-off method (drawing 5 (c)).
[0084] Although the above process constitutes the process which prepares the structure shown in drawing 5 (c), the process which prepares the structure shown in drawing 5 (c) is not necessarily limited to what is depended on such each process.
[0085] The Pyrex glass member 55 (equivalent to the base material 43 in drawing 4) by which the metal membranes 54 (equivalent to the electric conduction film 48,148 for wiring), such as gold by which patterning was carried out according to the configuration of said electric conduction film 48,148 for wiring, were formed in the inferior surface of tongue on the other hand is prepared (drawing 5 (d)). With the gestalt of this operation, slot 55a for avoiding that a tabular thing is used as a Pyrex glass member 55, and a garbage is joined by the anode plate junction mentioned later is beforehand formed in the inferior surface of tongue of processing by the dicing saw. If it puts in another way, a bridge is constructed over between the parts which should serve as said two or more base materials 43 for a cantilever by the part in which slot 55a is formed, and the Pyrex glass member 55 is making tabular as a whole. In addition, the slot for separation (not shown) is formed in the part in which slot 55a is formed.
[0086] Next, while a part of metal membrane 53 of the structure shown in drawing 5 (c) and a part of metal membrane 54 of the inferior surface of tongue of said Pyrex glass member 55 lap and contact So that a part of metal membrane 245 of the structure shown in

drawing 5 (c) and a part of other metal membranes 54 of the inferior surface of tongue of said Pyrex glass member 55 may lap and contact Alignment of said structure and said Pyrex glass member 55 is carried out, and anode plate junction of the inferior surface of tongue of the Pyrex glass member 55 is carried out on the top face of the silicon nitride film 51 of said structure (drawing 5 (d)). While a part of metal membrane 53 and a part of metal membrane 54 are stuck by pressure and connecting electrically at this time, a part of metal membrane 245 and a part of other metal membranes 54 will be stuck by pressure, and it will connect electrically.

[0087] Subsequently, the part in which said slot 55 in the Pyrex glass member 55 is formed is excised by processing by the dicing saw. However, said excision is not performed about the edges of the train in which said slot for separation is formed, and each train. Next, the structure of this condition is immersed in a KOH water solution or a TMAH water solution, and a substrate 50 is removed. Since there is nothing a limping gait crack completely as said excision mentioned above, each cantilever is connected also in this condition (that connection condition is not shown in drawing 5 .). Finally, it separates into each cantilever using said slot for separation. Thereby, the cantilever shown in drawing 4 is completed. But a cantilever [being connected] is supplied to a measurement person and a measurement person may be made to separate into each cantilever using said slot for separation.

[0088] In the cantilever shown in drawing 4 , while being able to adopt the accurate film formation technique in which aligners, such as the lift-off method, were used, in the case of film formation of a metal membrane 46,145 (namely, metal membrane 53,245) and being able to form the magnitude and the location of a both lap part, i.e., a thermocouple, with a very sufficient precision at it so that the explanation mentioned above may show, area of a thermocouple can be made small. Therefore, area of a thermocouple can be made small while being able to form the magnitude and the location of a thermocouple with a very sufficient precision. Consequently, in the cantilever shown in drawing 4 , the precision and resolution of measurement of the temperature distribution on the front face of a sample or thermal conductivity distribution become high.

[0089] Moreover, in the cantilever shown in drawing 4 , the probe 42 and the base material 43 have projected to the opposite direction to the flexible plate 41. Therefore, like the case of drawing 10 (b), the part (namely, lever section) to which the base material 43 in the flexible play 41 is not joined can be shortened, resonance frequency of the cantilever concerned can be made high, and rapid scanning can be realized so that the corner of a base material 43 may not hit a sample at the time of measurement.

[0090] Furthermore, in the cantilever shown in drawing 4 , the cantilever concerned can be mass-produced using the batch process using a semi-conductor manufacturing technology which was explained with reference to drawing 5 , and the cantilever concerned can be offered cheaply.

[0091] Next, other examples of the manufacture approach of the cantilever shown in drawing 4 are explained with reference to drawing 6 . Drawing 6 is the outline sectional view showing other examples of the production process of the cantilever shown in drawing 4 . In drawing 6 , the same sign is given to the same as that of the element in drawing 5 , or a corresponding element.

[0092] first -- as a substrate ingredient (100) -- the silicon substrate 50 with a diameter [of field bearing / of 3 inches], and a thickness of 250 micrometers -- using -- LPCVD -- the silicon nitride films 51 and 52 with a thickness of 700nm are formed to both sides of a substrate 50 by law (reduced pressure CVD method) etc. (a silicon nitride film 51 is equivalent to the flexible plate 41 in drawing 4). Next, opening 51a of the shape of a square to which the front face of a substrate 50 is exposed is formed in the predetermined part of a silicon nitride film 51 by carrying out patterning of the silicon nitride film 51 on top using the lithography method and the dry etching method. Also in this example, two or more cantilevers are manufactured to coincidence, and only the number corresponding to the number of the cantilevers which opening 51a tends to manufacture to coincidence is formed. In addition, the pattern configuration of opening 51a, magnitude, and quantity can be set as arbitration. Next, this substrate is immersed in the etching reagent for silicon, such as a potassium-hydroxide (KOH) water solution or a tetramethylammonium hydroxide (TMAH) water solution, silicon nitride films 51 and 52 are used as a mask, anisotropic etching of the part of the substrate 50 exposed from opening 51a is carried out, and trench 50a is formed in the bottom of opening 51a (drawing 6 (a)). Trench 50a is constituted by the silicon (111) side, and becomes a square drill-like crevice. In this example, trench 50a is constituted by the silicon (111) side, and becomes a square drill-like crevice.

[0093] Subsequently, heat the substrate of the condition which shows in drawing 6 (a) in an oxygen ambient atmosphere, the wall of trench 50a of the exposed substrate 50 is made to oxidize thermally (thermal oxidation of which format, such as wet oxidation and dry oxidation, is sufficient), and the oxidation silicon film 56 is formed (drawing 6 (b)). Since oxidization progresses late in the corner section of a silicon crystal, it becomes steep especially near the pars basilaris ossis occipitalis of trench 50a (i.e., the point of a square drill). In this example, it becomes a crevice for this trench 50a made steep to imprint the configuration of a probe 42.

[0094] Next, while carrying out patterning of the silicon nitride film 51 on top according to the configuration of the flexible plate 41 using the lithography method and the dry etching method, the silicon nitride film 52 at the bottom is removed (drawing 6 (c)).

[0095] Then, patterning of the metal thin films 53 (equivalent to the metal membrane 44 in drawing 4), such as Nichrome (NiCr), is carried out to the field which is equivalent to a wrap field and the electric conduction film 46 for wiring in trench 50a on the substrate of the condition which shows in drawing 6 (c) made steep by the lift-off method. Subsequently, patterning of the metal membranes 245 (equivalent to the metal membrane 145 in drawing 4), such as Ti, is carried out to the field equivalent to said electric conduction film 147 for wiring which extends on a silicon nitride film 51 from the field which laps with a metal membrane 53 in trench 50a on the substrate of this condition made steep, and the lap field concerned by the lift-off method (drawing 6 (d)).

[0096] Although the above process constitutes the process which prepares the structure shown in drawing 6 (d), the process which prepares the structure shown in drawing 3 (d) is not necessarily limited to what is depended on such each process.

[0097] The Pyrex glass member 55 (equivalent to the base material 43 in drawing 4) by which the metal membranes 54 (equivalent to the electric conduction film 48,148 for wiring), such as gold by which patterning was carried out according to the configuration of said electric conduction film 48,148 for wiring, were formed in the inferior surface of tongue on the other hand is prepared (drawing 6 (e)). With the gestalt of this operation, slot 55a for avoiding that a tabular thing is used as a Pyrex glass member 55, and a garbage is joined by the anode plate junction mentioned later is beforehand formed in the inferior surface of tongue of processing by the dicing saw. If it puts in another way, a bridge is constructed over between the parts which should serve as said two or more base materials 43 for a cantilever by the part in which slot 55a is formed, and the Pyrex glass member 55 is making tabular as a whole. In addition, the slot for separation (not shown) is formed in the part in which slot 55a is formed.

[0098] Next, while a part of metal membrane 53 of the structure shown in drawing 6 (d) and a part of metal membrane 54 of the inferio surface of tongue of said Pyrex glass member 55 lap and contact So that a part of metal membrane 245 of the structure shown in drawing 6 (d) and a part of other metal membranes 54 of the inferior surface of tongue of said Pyrex glass member 55 may lap and

contact Alignment of said structure and said Pyrex glass member 55 is carried out, and anode plate junction of the inferior surface of tongue of the Pyrex glass member 55 is carried out on the top face of the silicon nitride film 51 of said structure (drawing 6 (e)). While a part of metal membrane 53 and a part of metal membrane 54 are stuck by pressure and connecting electrically at this time, a part of metal membrane 245 and a part of other metal membranes 54 will be stuck by pressure, and it will connect electrically.

[0099] Subsequently, the part in which said slot 55 in the Pyrex glass member 55 is formed is excised by processing by the dicing saw. However, said excision is not performed about the edges of the train in which said slot for separation is formed, and each train. Next, the structure of this condition is immersed in a KOH water solution or a TMAH water solution, and a substrate 50 is removed. Since there is nothing a limping gait crack completely as said excision mentioned above, each cantilever is connected also in this condition (that connection condition is not shown in drawing 6 .). Finally, it separates into each cantilever using said slot for separation. Thereby, the cantilever shown in drawing 4 is completed. But a cantilever [being connected] is supplied to a measurement person and a measurement person may be made to separate into each cantilever using said slot for separation.

[0100] In the cantilever obtained by the manufacture approach explained with reference to drawing 6 , since the crevice for imprinting the configuration of a probe 2 is set to trench 50a made steep, compared with the cantilever manufactured by the manufacture approach explained with reference to drawing 5 , the point of a probe 43 is further radicalized and the resolution of measurement improves.

[0101] As mentioned above, although the gestalt of each operation of this invention was explained, this invention is not limited to the gestalt of these operations.

[Translation done.]

* NOTICES *

1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] It is drawing showing the cantilever by the gestalt of operation of the 1st of this invention, and is the outline sectional view where drawing 1 (a) met the outline perspective view, and drawing 1 (b) met the C-C line in drawing 1 (a).
[Drawing 2] It is the outline sectional view showing an example of the production process of the cantilever shown in drawing 1 .
[Drawing 3] It is the outline sectional view showing other examples of the production process of the cantilever shown in drawing 1 .
[Drawing 4] It is drawing showing the cantilever by the gestalt of operation of the 2nd of this invention, and the outline perspective view showing the cantilever according [drawing 4 (a)] to the gestalt of this operation and drawing 4 (b) are the outline sectional views in alignment with D-D line in drawing 4 (a).
[Drawing 5] It is the outline sectional view showing an example of the production process of the cantilever shown in drawing 4 .
[Drawing 6] It is the outline sectional view showing other examples of the production process of the cantilever shown in drawing 4 .
[Drawing 7] It is drawing showing an example of the conventional cantilever, and is the outline sectional view where drawing 7 (a) met the outline perspective view, and drawing 7 (b) met the A-A line in drawing 7 (a).
[Drawing 8] It is the outline sectional view showing an example of the production process of the cantilever shown in drawing 7 .
[Drawing 9] It is drawing showing other examples of the conventional cantilever, and drawing 9 (a) is the outline sectional view, and drawing 9 (b) is a B-B view outline top view in drawing 9 (a).
[Drawing 10] It is the outline sectional view showing typically signs that the sample front face is measured by the cantilever shown in the cantilever shown in drawing 7 , and drawing 9 .
[Description of Notations]
41 Flexible Plate
42 Probe
43 Base Material
44 45 Metal membrane
46, 47, 48,145,147,148 Electric conduction film for wiring
50 Substrate
51 52 Silicon nitride film
50a Trench
51a Opening
53, 54, 58,245 Metal membrane
55 Pyrex Glass Member
56 Oxidation Silicon Film

[Translation done.]